Leeds
CITY COUNCIL

Core Strategy

Leeds Local Development Framework

Development Plan Document
Strategic Flood Risk Assessment
October 2007

Ordnance Survey mapping

Downloading the web based document

The web based document is split into parts to make downloading quicker and easier for people without a broadband connection:

1. SFRA text and appendices (one PDF) – The full written text and appendices. Where the text refers to adjoining overview maps, reference will need to be made to the overview maps PDF.

2. Overview maps (3 PDFs) – Three separate maps of the whole of Leeds showing character areas, local flood incidents and brook catchments.

3. Index to area maps (one PDF) – One map showing the whole of Leeds and the location and reference numbers of the 39 local area maps providing detailed information on flood risks. Use this map to identify the area you are interested in and its reference number.

4. Area maps (39 PDFs) – Maps 1 to 39 are available as separate downloads. Each provides detailed information on flood risks in a particular locality. Refer to the index map to find out which local map to download for your area of interest.

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(Bengali):-

যদি আপনি ইংরেজীতে কথা বলতে না পারেন এবং এই দলিলটি বুঝতে পারার জন্য সাহায্যের দরকার হয়, তাহলে দয়া করে 0113 247 8092 এই নম্বরে ফোন করে আপনার ভাষাটির নাম বলুন। আমরা তখন আপনাকে লাইনে থাকতে বলে কোন দোভাষীর (ইন্টারপ্রিটার) সাথে যোগাযোগ করব।

(Chinese):-

凡不懂英語又須協助解釋這份資料者，請致電 0113 247 8092 並說明本身所需語言的名稱。當我們聯絡傳譯員時，請勿掛斷電話。

(Hindi):-

यदि आप इंग्लिश नहीं बोलते हैं और इस दस्तावेज़ को समझने में आपको मदद की ज़रूरत है, तो कृपया 0113 247 8092 पर फ़ोन करें और अपनी भाषा का नाम बताएँ। तब हम आपको होल्ड पर रखेंगे (आपको फ़ोन पर कुछ देर के लिए इंतज़ार करना होगा) और उस दौरान हम किसी इंटरप्रिटर (दुभाषिए) से संपर्क करेंगे।

(Punjabi):-

ਅਗਰ ਤੁਸੀਂ ਅੰਗਰੇਜ਼ੀ ਨਹੀਂ ਬੋਲਦੇ ਅਤੇ ਇਹ ਲੇਖ ਪੱਤਰ ਸਮਝਣ ਲਈ ਤੁਹਾਨੂੰ ਸਹਾਇਤਾ ਦੀ ਲੋੜ ਹੈ, ਤਾਂ ਕਿਰਪਾ ਕਰ ਕੇ 0113 247 8092 ‘ਤੇ ਟੈਲੀਫ਼ੂਨ ਕਰੋ ਅਤੇ ਅਪਣੀ ਭਾਸ਼ਾ ਦਾ ਨਾਮ ਦੱਸੋ. ਅਸੀਂ ਤੁਹਾਨੂੰ ਟੈਲੀਫ਼ੂਨ ‘ਤੇ ਹੀ ਰਹਿਣ ਲਈ ਕਹਾਂ ਗੇ, ਜਦ ਤਕ ਅਸੀਂ ਦੁਭਾਸ਼ੀਏ (Interpreter) ਨਾਲ ਸੰਪਰਕ ਬਣਾਵਾਂ ਗੇ.

(Urdu):-

اگر آپ انگریزی نہیں بولتے ہیں اور آپ کو یہ دستاویز سمجھنے کیلئے مدد کی ضرورت ہے تو براہِ مہربانی اس نمبر 0113 247 8092 پر فون کریں اور ہمیں اپنی زبان کا نام بتائیں۔ اس کے بعد ہم آپ کو لائن پر ہی انتظار کرنے کیلئے کہیں گے اور خود ترجمان (انٹرپریٹر) سے رابطہ کریں گے۔

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EXECUTIVE SUMMARY

Introduction

1. The Metropolitan District of Leeds extends from Otley in the north west, to Wetherby in the north east, to Allerton Bywater in the south east and to Morley in the south west. The District encompasses the major population centre of Leeds. A large proportion of the District is designated Green Belt, interspersed by a number of suburbs, towns and villages.

2. The River Aire, River Wharfe and their tributaries are a dominant feature of the District. A very large proportion of the local communities are situated adjacent to, or near, these rivers and/or their tributaries. The south-eastern boundary of the District is adjacent to the River Calder and Leeds also experiences flooding from this River. The Environment Agency estimates that there are 1500 homes and 500 businesses at 'significant' risk of river flooding within the District, and indeed parts of Leeds City Centre - the economic and commercial heart of not only the District, but the wider region – are estimated to have an alarming 1 in 20 year risk of flooding from the River Aire.

3. The recent flooding within the District (June 2007) is a timely reminder of the potential impact that floodwaters can have upon homes and businesses. It is important to remember that the risk of flooding is posed not only by rivers within the District, but also by surface water runoff (or flash flooding) and the surcharging of sewers during particularly heavy and/or prolonged rainfall. Future development can exacerbate problems of this nature if not carefully designed, blocking flow paths and increasing the magnitude and speed of runoff from the site.

4. The Leeds Strategic Flood Risk Assessment (SFRA) has been carried out to deliver the following key outcomes:

   - To collate all known sources of flooding, including river, surface water (local drainage), sewers and groundwater, that may affect existing and/or future development within the District;

   - To delineate areas that have a 'low', 'medium' or 'high' probability of flooding within the District, defined in accordance with Planning Policy Statement 25 (PPS25), and to map these[1];

   - To consider the risk of flooding, taking due consideration of the likely depth and speed of the flow, assessing the likely consequence that this may pose to life and property within the District[2];

   - Within flood affected areas, recommend appropriate land uses (in accordance with the PPS25 *Sequential Test*) that will not unduly place people or property at risk of flooding;

   - Where flood risk has been identified as a potential constraint to future development, recommend possible flood mitigation solutions that may be integrated into the design (by the developer) to minimise the risk to property and life should a flood occur (in accordance with the PPS25 *Exception Test*).

Flood Risk within the District of Leeds

5. A number of towns and villages are at risk of flooding from rivers within the District of Leeds, including a considerable proportion of Leeds City Centre. Indeed, the Environment Agency estimates that there are over 2000 properties at 'significant' risk of river flooding within the District of Leeds, susceptible to a 1.33% chance of flooding.

[1] Commensurate with a Level 1 SFRA in accordance with the PPS25 Companion Practice Guide (A Living Draft, February 2007)
[2] Commensurate with a Level 2 SFRA in accordance with the PPS25 Companion Practice Guide (A Living Draft, February 2007)

6. An overview of the risk of flooding posed to properties within the District of Leeds is presented graphically as Figure A.

7. Some structures that provide a flood defence function are present along the River Aire and the River Wharfe, however, very few are formally maintained flood defences. These may increase the standard of protection provided to properties situated behind the structures in some areas but there is always a residual risk that these structures may be overtopped in more extreme flood events or fail in some way. It is crucially important therefore that future development takes careful consideration of the possible risk to life should a flood occur.

8. Smaller watercourses and drains are far more susceptible than the larger river systems to 'flashier' flooding as a result of localised intense rainfall. Flooding of this nature can often catch people off guard, resulting in a very rapid increase in water levels, often without warning. With changing climate patterns it is expected that storms of this nature will become increasingly common, potentially increasing the risk posed to properties situated in close proximity to local streams.

9. In addition to river flooding, there is also a risk to properties posed as a result of localised flooding issues including groundwater flooding, surface water runoff and/or surcharging of the underground sewer system. Many developed areas of Leeds rely upon ageing underground networks to capture and convey local runoff. Not surprisingly, elements of these ageing networks have insufficient capacity to cater for ever increasing urban development within the district. Culvert blockages have also been known to occur, due to the washing down of litter and/or vegetation from the upper catchment during a heavy rainfall event. These localised flooding issues affect many parts of the district, both within river floodplain areas, and in areas of higher ground away from the floodplain.

Why carry out a Strategic Flood Risk Assessment (SFRA)?

10. Flooding can result not only in costly damage to property, but can also pose a risk to life and livelihood. It is essential that future development is planned carefully, steering it away from areas that are most at risk from flooding, and ensuring that it does not exacerbate existing flooding.

11. *Planning Policy Statement 25: Development and Flood Risk (PPS25)* has been developed to underpin decisions relating to future development (including urban regeneration) within areas that are subject to flood risk. In simple terms, PPS25 requires local planning authorities to review the variation in flood risk across their District, and to steer vulnerable development (e.g. housing) towards areas of lowest risk. The SFRA helps to do this by mapping the variations in river flooding and by indicating where there are other known sources of flooding.

12. **In allocating land for development, it is essential that the Local Authority applies the principles of the Sequential Test at the earliest stage in the planning process.** The sequential test requires that land for future development must first be sought within Zone 1 Low Probability. Only if it can be demonstrated that, for sound planning reasons, there are no suitable sites within this area, can sites elsewhere within the District be considered. Sites must then be sought within Zone 2 Medium Probability. Once again, only if it can be conclusively shown that there are sound planning reasons that outweigh the risk of flooding, can sites be considered for allocations in Zone 3 High Probability.

13. Where the Sequential Test has been applied, and the Local Authority considers that there are sound reasons to allocate a site within Zone2 or Zone 3 on planning grounds, then PPS25 requires the Council to demonstrate that there are sustainable mitigation solutions available that will ensure that the risk to property and life is minimised (throughout the lifetime of the development) should flooding occur. **This is through the application of the Exception Test and site specific Flood Risk Assessments.**

14. The Strategic Flood Risk Assessment (SFRA) is the first step in this process, and it provides the building blocks upon which the Council's planning and development control decisions can be made. PPS25 was released in December 2006, and forms the basis for guiding planning decisions within flood affected areas. PPS25 was supplemented by the Practice Guide Companion (A Living Draft) in February 2007, and this SFRA has been developed with due consideration to both guidance documents.

How has the Strategic Flood Risk Assessment (SFRA) been developed?

15. The Leeds SFRA has been developed in close consultation with representatives from Leeds City Council (Land Drainage and Planning and Economic Policy) and the Environment Agency. Input has also been sought from Yorkshire Water, the Yorkshire & Humber Assembly, and the Leeds City Council's Emergency Planning Unit. It is important to highlight that the information received from Yorkshire Water was very general in nature, providing simply a summary of the number of properties flooded per post code in recent years. No specific data relating to systems that are at, have exceeded, or are nearing their design capacity (and therefore may pose a potential risk of flooding) could be made available for confidentiality reasons.

16. The District has been delineated into zones of low, medium and high probability of flooding including functional floodplain and further consideration of the variation in the high probability flood zone 3. The delineation of the flood zones has been carried out based upon the collation and interpretation of existing knowledge with respect to flooding, sourced largely from Leeds City Council and the Environment Agency. Detailed flood risk mapping has been made available by the EA for the River Aire, the River Wharfe and Wyke Beck corridors, providing the primary basis for flood zone delineation where applicable. The Environment Agency Flood Zone Maps (September 2006) have been adopted as the basis for the SFRA in those areas in which detailed flood risk mapping is not available.

Application of the Leeds SFRA

17. PPS25 requires that the Sequential Test is applied at all stages of the planning process, including both the allocation of land for future development (i.e. by the Council) and at the planning application stage (i.e. by the developer). The Leeds SFRA has been prepared to inform the application of the Sequential Test. Where the Sequential Test cannot be satisfied and it is necessary to consider the requirements of the Exception Test, the SFRA provides guidance as to the minimum design considerations that will be required to ensure that the proposed development is sustainable throughout its design life and assist in completion of site specific Flood Risk Assessments.

18. The spatial variation in flood risk across the District has been delineated in the following manner:

Zone 3b (Functional Floodplain)

19. Zone 3b Functional Floodplain is land:
    - where water flows or has to be stored in times of flood;
    - that is subject to flooding with a 1 in 20 year (5%) probability (or more frequently); and
    - that is reserved by Leeds City Council for this purpose

    Where the Council has identified that undeveloped land already has an existing planning permission or a brownfield allocation that has been protected through the 'Saved Policies' review of the Leeds Unitary Development Plan, then a decision has been made not to include it in the functional floodplain.

    The functional floodplain therefore primarily consists of the broad open spaces adjoining the waterway corridors of the River Wharfe and River Aire. It is essential that these floodplain areas are protected from future development.

Zone 3a High Probability

20. Areas subject to flooding up to (and including) a 1 in 100 year (1%) annual probability of flooding have been identified. This is denoted as Zone 3a High Probability within PPS25. Within Leeds however, there is a considerable variation in the depth, duration and frequency (and hence the consequence) of flooding to properties situated within Zone 3a. As a result, a further sub-delineation of flood risk has been carried out to assist the Council planning team to guide future development to areas of lowest risk within Zone 3a, when it is not possible to find reasonable alternatives in a lower risk zone.

21. Existing developed areas (or areas with existing planning permission or an allocation that has been protected through the 'Saved Policies' review of the Leeds UDP) that are subject to flooding up to (and including) the 1 in 20 year (5%) annual probability have been highlighted as Zone 3a(ii) High Probability. This primarily includes areas of existing development situated adjacent to the River Aire and the River Wharfe (including Leeds City Centre). Existing Sewage Treatment Works have also been incorporated into Zone 3a(ii) for planning purposes[3]. This is to allow them to upgrade if necessary so that they can continue to effectively treat the sewage arising from existing and future development. If and when these Sewage Treatment Works become redundant they will revert to areas of 3b functional floodplain.

22. Areas situated within the 1% (100 year) flood envelope, but outside of the 5% (20 year) flood envelope, have been delineated as Zone 3a(i) High Probability. Residents whose homes are situated within Zone 3a(i) and 3a(ii) are vulnerable to flooding, as has been demonstrated in the recent flooding within Yorkshire and Gloucestershire in July 2007. Housing should be avoided in both zone 3a(ii) and 3a(i) wherever possible and where the LPA considers that housing is appropriate it must apply the Exceptions Test to show that there are wider sustainability benefits resulting from the development.

23. PPS25 restricts the allocation of Highly Vulnerable development within Zone 3, including emergency services and response centres. These may only be permissible following the successful application of the Exception Test to ensure that the risk of flooding can be mitigated safely, and in a sustainable manner, throughout the lifetime of the development.

24. Where strong planning arguments dictate a need to consider further the viability of potential future development within Zone 3a, it will be essential for the Council to impose robust design conditions to ensure future sustainability throughout the lifetime of the development as well as the Exception Test for 'more vulnerable' development eg. housing. To this end, the SFRA has outlined specific development control recommendations that should be placed upon development within Zones 3a(i) and 3a(ii) High Probability to minimise both the damage to property, and the risk to life in case of flooding.

25. Opportunities to deliver strategic flood risk management options may also be sought, possibly seeking external funding and/or developer contributions to pave the way for investment in, for example, raised flood defences through Leeds City Centre. The Environment Agency is currently investigating the benefits of a Leeds Flood Alleviation Scheme, however such a scheme will only defend existing development and any new development in flood risk areas will still have a need for defence (which requires consideration at the time of any application for planning permission).

Zone 2 Medium Probability

26. Areas subject to flooding in events exceeding the 1% (100 year) event, and up to (and including) the 0.1% (1000 year) event (i.e. Zone 2 Medium Probability) have been identified. Future development may only be considered within Zone 2 Medium Probability if it can be demonstrated that there are no suitable sites available within Zone 1 Low Probability.

[3] This designation is adopted solely to permit future augmentation of the existing STW, and following decommissioning the sites will revert to Zone 3b Functional Floodplain

27. PPS25 restricts the allocation of Highly Vulnerable development (including emergency services and response centres) to zones 1 and 2. These may only be permissible in zone 2 following the successful application of the Exception Test to ensure that the risk of flooding can be mitigated safely, and in a sustainable manner, throughout the lifetime of the development.

Zone 1 Low Probability

28. PPS25 does not constrain the type of development taken forward within Zone 1 Low Probability (i.e. all remaining areas of the District), defined as having less than 0.1% (1 in 1000 year) annual probability of flooding. It is important to remember however that development within these areas, if not carefully managed, may exacerbate existing flooding and/or drainage problems downhill. It is necessary therefore to ensure that developers carry out a Flood Risk Assessment which concentrates on surface water. This should demonstrate that the proposed drainage system design will mitigate any possible increase in runoff that may occur from the site as a result of the proposed development.

PPS25 Constraints upon Emerging Future Development within Leeds

29. A review of current allocated sites for future development within the District has been undertaken in light of the findings of the Leeds SFRA. It is highlighted that this review of sites does not attempt to address in any way the requirement for a sequential approach to the allocation of sites, as required by PPS25. Rather, it simply endeavours to identify potential flooding related constraints that may impact upon the future sustainability of the development should it be taken forward.

30. Whilst a large proportion of the anticipated demand for future development sites within Leeds can be satisfied within areas that are not at risk from fluvial flooding, there are a small number of strategic, regeneration sites that currently fall within the High Probability flood zones.

31. The Stourton Riverside and Hunslett Mills sites identified within the Aire Valley Area Action Plan (AAP) are situated within Zone 3a(ii) High Probability, and are at risk of flooding from the River Aire in the 1 in 20 year flood event. The proposed regeneration of the Kirkstall Road area is also affected by flooding from the River Aire at this frequency for some parts of the site. There is also considerable pressure for the redevelopment of brownfield areas within Leeds City Centre, a large proportion of which is at risk of flooding from the River Aire in the 1 in 20 year flood event. Within these areas any redevelopment should ensure that opportunities are taken to increase the flood storage within the site and defences may be required. The whole area of the site should not be viewed as developable and the recommendations in section 6.4.3 should also be referred to.

32. The future sustainability of development within an area at regular risk of flooding must be carefully considered, particularly where residential development is proposed. It is strongly recommended that the sites at risk of flooding are carefully reviewed in light of the SFRA. Development should only be considered if it can be shown that there are robust planning arguments that outweigh the flood risk. It is essential that the proposed land use is appropriate given the severity of the risk of flooding posed to the site.

33. In consultation with the Environment Agency and Leeds City Council, the SFRA has developed a suite of specific spatial planning and development control recommendations that should underpin all future development within Zones 3a(ii) and 3a(i) respectively. These recommendations have been developed in recognition of the direct risk posed by flooding to life and property within these areas, and it is essential that future planning decisions are taken with careful consideration of these recommendations (see sections 6.4.3 and 6.4.4).

The Way Forward

34. A considerable proportion of Leeds is at risk of flooding. The risk of flooding posed to properties within the District arises from a number of sources including river flooding, localised runoff (surface water flooding), and sewer flooding. This risk is likely to increase due to the impact of climate change.

35. Very few flood defences exist within the District but many riverside retaining structures perform a flood defence function. These are often not specifically designed to retain flood water although some may provide a degree of protection to existing property, however, a residual risk of flooding remains. This is associated both with an event that overtops the retaining structures and/or a structural failure because their design capacity has been exceeded.

36. A planning solution to flood risk management should be sought wherever possible, steering vulnerable development away from areas affected by flooding in accordance with the PPS25 Sequential Test, and ensuring that future development does not exacerbate existing flooding. In the first instance it is important to AVOID the risk.

37. Where planning considerations demonstrate that the allocation of sites in flood risk areas is necessary and the Sequential Test can be satisfied, specific recommendations have been provided to assist the Council and the developer to meet the Exception Test. These should be applied as development control recommendations for all future development. Developers should also seek to take a sequential approach to the positioning of land uses and layout of a development **within** a large development site, so that the more vulnerable uses are located in the least risk parts of the site.

38. Robust Council policy is essential to ensure that the recommended development control recommendations can be imposed consistently at the planning application stage. This is essential to achieve future sustainability within the district with respect to flood risk management. It is recommended that a review of Council Policy N38A is carried out in response to the recent release of PPS25, and the findings and recommendations of the Leeds City Council SFRA.

39. Emergency planning is imperative to minimise the risk to life posed by flooding within the district. It is recommended that the Council refer the risks identified as an outcome of this SFRA to the Emergency Planning Unit so that these may be used to inform the work of the local Resilience Forum.

A Living Document

40. The SFRA has been developed building heavily upon existing knowledge with respect to flood risk within the district. A rolling programme of detailed flood risk mapping within the North East region is underway. This, in addition to observed flooding that may occur throughout a year, will improve the current knowledge of flood risk within the district and may marginally alter predicted flood extents within Leeds. Furthermore, Communities and Local Government (CLG) are working to provide further detailed advice with respect to the application of PPS25, and future amendments to the PPS25 Practice Guide are anticipated. Given that this is the case, a periodic review of the Leeds City Council SFRA is imperative.

41. It is recommended that the Leeds City Council SFRA is reviewed once every 12 months, commencing in July 2008. A series of key questions to be challenged as part of the SFRA review process are set out in Section 7 of this document.

Table of Contents

Glossary

AEP	Annual Exceedance Probability e.g. 1% AEP is equivalent to 1% probability of occurring (or being exceeded) in any one year
Core Strategy	The Development Plan Document within the Council's Local Development Framework which sets the long-term 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.
DCLG	Department of Communities and Local Government
Defra	Department of Environment, Food and Rural Affairs
Development	The carrying out of building, engineering, mining or other operations, in, on, over or under land, or the making of any material change in the use of a building or other land.
Development Plan Document (DPD)	A spatial planning document 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.
DPD	Development Planning Document
EA	Environment Agency
Flood Zone Map	Nationally consistent delineation of 'high' and 'medium' flood risk, published on a quarterly basis by the Environment Agency
Formal Flood Defence	A structure built and maintained specifically for flood defence purposes
Functional Floodplain	PPS25 Flood Zone, defined as open areas at risk of flooding in the 5% AEP (1 in 20 year annual probability of flooding) design event where water flows and has to be stored in times of flood
Habitable Room	A room used as living accommodation within a dwelling but excludes bathrooms, toilets, halls, landings or rooms that are only capable of being used for storage. All other rooms, such as kitchens, living rooms, bedrooms, utility rooms and studies are counted.
Zone 3a High Probability	PPS25 Flood Zone, defined as areas at risk of flooding at less than the 1% AEP (1 in 100 year annual probability of flooding) design event
Informal Flood Defence	A structure that provides a flood defence function but has not been built and/or maintained for this purpose (e.g. boundary wall)
LCC	Leeds City Council
Local Development Framework (LDF)	Consists of a number of documents which together form the spatial strategy for development and the use of land
Zone 1 Low Probability	PPS25 Flood Zone, defined as areas less likely to flood than those in Zone 2 Medium Probability and having a less than 1 in 1000 annual probability of river flooding (<0.1%)

Zone 2 Medium Probability	PPS25 Flood Zone, defined as areas at risk of flooding in events that are greater than the 1% AEP (1 in 100 year annual probability of flooding), and less than the 0.1% AEP (1 in 1000 year) design event
Planning Policy Guidance (PPG)	A series of notes issued by the Government, setting out policy guidance on different aspects of planning. They are being replaced by Planning Policy Statements.
Planning Policy Statement (PPS)	A series of statements issued by the Government, setting out policy guidance on different aspects of planning. They will replace Planning Policy Guidance Notes.
PPG25	Planning Policy Guidance 25: Development and Flood Risk Office of the Deputy Prime Minister (ODPM), 2001
PPS25	Planning Policy Statement 25: Development and Flood Risk Department of Communities & Local Government, December 2006
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.
Residual Risk	A measure of the outstanding flood risks and uncertainties that have not been explicitly quantified and/or accounted for as part of the review process
SEA	Strategic Environmental Assessment
SUDS	Sustainable Urban Drainage System
Supplementary Planning Document (SPD)	Provides supplementary guidance to policies and proposals contained within Development Plan Documents. They do not form part of the development plan, nor are they subject to independent examination.
Sustainability Appraisal (SA)	Appraisal of plans, strategies and proposals to test them against broad sustainability objectives.
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).

1 Introduction

1.1 Context and Purpose

42. The Metropolitan District of Leeds extends from Otley in the north west, to Wetherby in the north east, to Allerton Bywater in the south east and to Morley in the south west. The District encompasses the major population centre of Leeds. A large proportion of the District is designated Green Belt, interspersed by a number of suburbs, towns and villages.

43. The River Aire, River Wharfe and their tributaries are a dominant feature of the District. A large proportion of the local communities are situated adjacent to, or near, these rivers and/or their tributaries. Additionally the River Calder flows along the south-eastern boundary of the District where it adjoins Wakefield and this also poses a risk of flooding in the Leeds area. The Environment Agency estimates that there are 1500 homes and 500 businesses at 'significant' risk of flooding' within the District. Flooding represents a risk to both property and life. It is essential therefore that planning decisions are informed, and take due consideration of the risk posed to (and by) future development by flooding.

44. Planning Policy Statement 25: Development and Flood Risk (PPS25) requires that local planning authorities prepare a SFRA in consultation with the Environment Agency. The primary purpose of the SFRA is to determine the variations in flood risk across the District. Robust information on flood risk is essential to inform and support the Council's revised flooding policies in its emerging Local Development Framework (LDF). Jacobs were commissioned by Leeds City Council in September 2006 to develop a Strategic Flood Risk Assessment (SFRA).

45. This SFRA for Leeds is being developed in tandem with the detailed preparation of the Leeds City Council planning framework. The SFRA has been developed based upon the best available information regarding flood risk within the district at the time of writing, and will inform the allocation of land for employment and/or housing. Understanding of flood risk will improve over time and it is important that the SFRA is adopted as a 'living' document and is reviewed regularly in light of emerging policy directives and an improved understanding of flood risk.

1.2 Study Area

46. The study area includes the whole of the District of Leeds. This area is located to the east of Bradford; west of York and north of Wakefield. The area of the district is 55,173 hectares and it has a population of 715,404 (2001 Census).

47. The District includes the large settlement of Leeds, and a number of smaller settlements including Wetherby, Otley, Guiseley, Yeadon, Horsforth, Bramhope, Roundhay, Garforth, Kippax, Rothwell, Middleton, Pudsey, Boston Spa, Collingham, Thorner, Barwick and Scholes.

48. The West Yorkshire Region is a vital part of the economically buoyant North East area. As part of this, Leeds is regarded as a prosperous area with a thriving local economy and low unemployment record (24.1% unemployment rate (June 2006-August 2006), National Average 24.8%). Leeds has excellent communications being located near to the motorway network (including M1, M62 and A1M) and the national rail network.

2 SFRA Approach

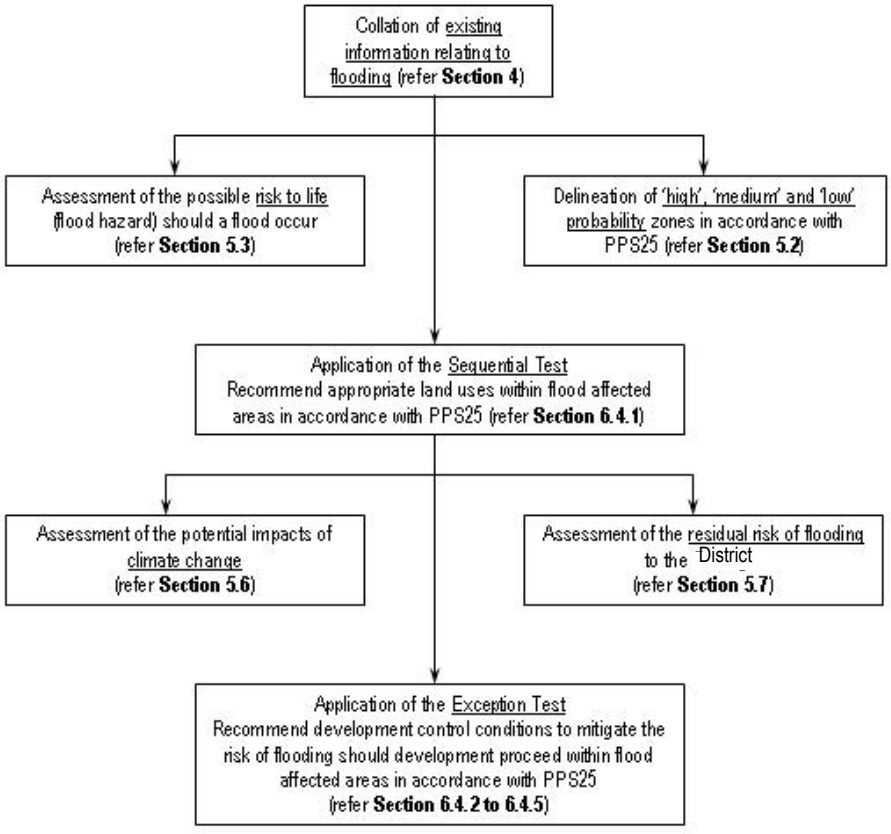
49. The primary objective of the Leeds SFRA is to inform the revision of flooding policies, including the allocation of land for future development. Furthermore, the SFRA has a broader purpose and in providing a robust depiction of flood risk across the district it can:

    - Inform the development of Council policy that will underpin decision making within the District, particularly within areas that are affected by (and/or may adversely impact upon) flooding;
    - Assist the development control process by providing a more informed response to development proposals affected by flooding, influencing the design of future development within the District;
    - Help to identify and implement strategic solutions to flood risk, providing the basis for possible future flood attenuation works;
    - Support and inform the Council's emergency planning response to flooding.

50. The Government provides no specific methodology for the SFRA process. Therefore, to meet these broader objectives, the SFRA has been developed in a pragmatic manner in close consultation with both the Council and the Environment Agency.

51. A considerable amount of knowledge exists with respect to flood risk within the District, including information relating both to historical flooding and the predicted extent of flooding under extreme weather conditions (i.e. as an outcome of detailed flood risk modelling carried out by the Environment Agency). The Leeds SFRA has built heavily upon this existing knowledge, underpinning the delineation of the district into 'high', 'medium' and 'low' risk zones, in accordance with PPS25. These zones have then been used to provide a robust and transparent evidence base for the development of flooding related policy and the allocation of sites for future housing and employment uses.

52. A summary of the adopted SFRA process is provided in the figure below, outlining the specific tasks undertaken, and the corresponding structure of the SFRA report.



53. It is important to recognise that some of the rivers that affect Leeds flow into, or from, adjoining authorities. Future development within the District, if not carefully managed, can influence the risk of flooding posed to residents within neighbouring areas. Conversely, careless planning decisions within adjacent districts can also impact adversely upon flooding within the district. For example, development along the River Aire and its tributaries could cause more flooding problems for the Castleford area if appropriate mitigation is not incorporated; this is an area which is known to be prone to flooding.

54. A number of authorities within the Aire Valley and Wharfe Valley are carrying out similar strategic flood risk investigations at the current time. Whilst the delivery teams and programmes underpinning these studies vary from one district to the next, all are being developed in close liaison with the Environment Agency. Consistency in adopted approach and decision making with respect to the effective management of flood risk throughout the Aire and Wharfe system is imperative. Regular discussions with the Environment Agency have been carried out throughout the SFRA process to this end, seeking clarity and consistency where needed.

3 Policy Framework

3.1 Introduction

55. This section provides a brief overview of the strategy and policy context relevant to flood risk in the District.

56. The success of the SFRA is heavily dependent upon the Council's ability to implement the recommendations put forward for future sustainable flood risk management, both with respect to planning decisions and development control recommendations (refer Sections 6.4 and 6.5). A framework of national and regional policy directive is in place, providing guidance and direction to local planning authorities. However, it is ultimately the responsibility of the Council to establish robust policies that will ensure future sustainability with respect to flood risk.

3.2 National Policy

3.2.1 Overview

57. National planning policy is set out through a number of Planning Policy Statements (PPS's) and Planning Policy Guidance Notes (PPG's). The Government is currently reviewing all PPG's with revised advice being set out in a PPS and, where necessary, accompanying best practice guidance.

58. PPS's and PPG's cover a full range of planning issues drawing on the central issue of sustainable development. Central themes include the re-use of previously developed land and the wish to steer inappropriate (or vulnerable) development away from areas at risk of flooding. It is a requirement that the LDF is consistent with Government planning policy.

3.2.2 Planning Policy Statement (PPS) 25: Development and Flood Risk

59. Planning Policy Statement 25 (PPS25) was released in December 2006, and underpins the process with which local planning authorities are to account for flood risk as an integral part of the planning process. The over-arching principles set out by PPS25 for the management of flood risk at local planning authority level are broadly encapsulated in Paragraph 6 of the document:

> *"Regional planning bodies (RPBs) and local planning authorities (LPAs) should prepare and implement planning strategies that help to deliver sustainable development by:*
>
> *Appraising Risk*
>
> - *identifying land at risk and the degree of risk of flooding from river, sea and other sources in their areas;*
> - *preparing Regional Flood Risk Assessments (RFRAs) or Strategic Flood Risk Assessment (SFRAs) as appropriate, as freestanding assessments that contribute to the Sustainability Appraisal of their plans;*
>
> *Managing Risk*
>
> - *framing policies for the location of development which avoid flood risk to people and property where possible, and manage any residual risk, taking account of the impacts of climate change;*

- *only permitting development in areas of flood risk when there are no reasonably available sites in areas of lower flood risk and the benefits of the development outweigh the risks from flooding;*[4]

Reducing Risk

- *safeguarding land from development that is required for current and future flood management e.g. conveyance and storage of flood water, and flood defences;*
- *reducing flood risk to and from new development through location, layout and design, incorporating sustainable drainage systems (SUDS);*
- *using opportunities offered by new development to reduce the causes and impacts of flooding e.g. surface water management plans; making the most of the benefits of green infrastructure for flood storage, conveyance and SUDS; re-creating functional floodplain; and setting back defences;*

A Partnership Approach

- *working effectively with the Environment Agency, other operating authorities and other stakeholders to ensure that best use is made of their expertise and information so that plans are effective and decisions on planning applications can be delivered expeditiously; and*
- *ensuring spatial planning supports flood risk management policies and plans, river Basin Management Plans and emergency planning."*

60. These broad planning objectives effectively set the scope for the specific outcomes of the SFRA process. The SFRA in turn then informs planning and development control decisions to ensure that the objectives set out above can be achieved.

61. The guidance in PPS25 also indicates that Sustainability Appraisals should be informed by the SFRA for their area. Under the Town and Country Planning (Local Development) (England) Regulations 2004, a Sustainability Appraisal (SA) is required for all Local Development Frameworks (LDFs). The purpose of SA is to promote sustainable development through better integration of sustainability considerations in the preparation and adoption of plans. The Regulations stipulate that SA of LDFs should meet the requirements of the SEA Directive.

62. It is important to reiterate that PPS25 is not applied in isolation as part of the planning process. The formulation of Council policy and the allocation of land for future development must also meet the requirements of other planning policy directives, including (for example) PPS3: Housing.

63. This may introduce some apparent conflict in national policy direction. For example, PPS3 requires that "new housing should be built on previously developed land before greenfield land". PPS25 reiterates this directive within its Exception Test, however, within the district a considerable proportion of the existing brownfield land is situated within flood affected areas. The PPS25 Sequential Test recommends that residential development should not be permitted in these areas.

64. Clearly a careful balance must be sought in these instances, and the SFRA aims to assist in this process through the provision of a clear and robust evidence base upon which informed decisions can be made.

65. The Practice Guide Companion to PPS25 was released in draft form for consultation by Communities and Local Government in February 2007, providing additional guidance on the principles set out in PPS25.

[4] From a planning perspective, this should be adopted as a preferred option, i.e. avoiding the risk of flooding, rather than attempting to mitigate it through engineered design

3.3 Regional Planning Policy

3.3.1 Regional Planning Guidance for Yorkshire and the Humber (RSS 12), 2004

66. Regional planning policies provide the overarching framework for the preparation of the LDF. RSS 12 covers the period up to 2012. The RSS was published in December 2004 and is the current adopted RSS for Yorkshire and the Humber. Leeds is identified as the dominant regional economic centre competing with other major cities. In accordance with policies P1, E4 and H2, it is one of the areas focused for economic and housing development in the West Yorkshire sub-region.

67. RSS 12 acknowledges that climate change is likely to exacerbate the risk of flooding within river floodplains and especially in the winter months.

    "…the regions climate will become warmer with winters becoming wetter and summers drier. It also shows that there will be increases in rainfall intensity, and that extreme events, such as droughts and floods, will become more frequent."

68. Policy R2b states that "*development plans should adopt a sequential risk based approach to development and flooding*". Following the application of the Sequential Test the policy also recognises there are exceptions (e.g. economic or social regeneration), that outweigh flood risk issues. In these cases, consultation should be carried out with the Environment Agency and other relevant organisations. This should ensure that any necessary protection and mitigation is provided and consistent with relevant management plans.

69. The policy also requires that development in the functional floodplain and washlands should be avoided. In previously developed areas, and areas of undeveloped floodplain where the risk from flooding is lower, development should be of appropriate type and design and will require the availability or provision of an appropriate standard of flood defence and the incorporation of flood mitigation and/or flood warning measures. For development proposed in flood risk areas the policy requires a flood risk assessment to be undertaken and submitted alongside the planning application.

70. As a result of these issues this policy guidance requires the Environment Agency and Local Authorities to work together to introduce proactive measures for the reduction of and protection against flood risk.

3.3.2 The Yorkshire and Humber Plan – RSS 12, Draft for Public Consultation

71. This RSS was published in December 2005 and has not yet been adopted. However, it is still relevant when considering the regional policies. The plan guides development up to 2021, and beyond. The plan identifies that the Leeds City Region is forecast to experience the greatest economic growth and is likely to remain the most significant economic driver of the Regions economy. Policy LCR1 recognises the important economic role Leeds plays within the Region and in particular recognises that the Aire Valley and East Leeds are sub-regionally significant economic development and housing regeneration opportunities which require major infrastructure investment.

72. The Yorkshire and Humber Plan also recognises that climate changes will increase the risk of flooding and Policy YH2 requires Local Authorities to, "*Plan for the successful adaptation of the predicted impacts of climate change by minimising threats from and impact of coastal erosion, increased flood risk, increased storminess, habitat disturbance, increased pressure on water resources supply and drainage systems*."

73. Policy ENV1 Floods and flood risk states that "development in high flood risk areas will be avoided, where possible, and flood management will be undertaken proactively". The policy requires that allocations of areas for development will need to take place in line with strategic flood risk assessments, and that flood management will be required to

facilitate development in Leeds where there is little development land available outside high risk flood zones.

74. The purpose of this policy is to inform development on the basis of strategic flood risk assessments and ensure flood management reflects regional spatial and economic priorities, as well as environmental objectives, thereby helping to maintain protection of the major conurbations and communities. Paragraph 15.7 states that Local Authorities should undertake strategic flood risk assessments in line with regional Supplementary Planning Guidance and then adopt a risk based sequential approach to flooding for new development in high flood risk areas; determine the balance between blight and flood risk, especially in regeneration areas.

75. The Examination in Public into the draft Regional Spatial Strategy (RSS) concluded in October 2006, and the Report of the Panel was released in March 2007. Chapter 6 (Volume 1), Section C of the Panel Report relates specifically to Flood Risk and Water Resources. The Panel Report raises concern that, whilst it is recognised that the draft RSS precedes the final release of PPS25 in December 2006, Policy ENV1 "does not take adequate account of the need to consider the implications of development in areas of flood risk." Furthermore, the Panel Report considers "the Plan did not give enough prominence to flood risk in relation to strategic patterns of development." For this reason, specific amendments to Policy ENV1 have been recommended in line with Environment Agency suggested changes[5].

76. The Secretary of State has published Proposed Changes to the draft RSS (28 September 2007) which propose a revised policy for ENV1 which takes an even stronger line on preventing inappropriate development in high flood risk areas. The revised ENV1 states:

ENV1

A The Region will manage flood risk pro-actively by reducing the causes of flooding to existing and future development, especially in tidal areas, and avoid development in high flood risk areas where possible.

B Allocation of areas for development will follow a sequential approach and will be in the lowest risk sites identified by Strategic Flood Risk Assessments.

C

Flood management will be required to:

1. Facilitate development in the cities of Leeds, Bradford, Sheffield, Hull and York, coastal towns including Bridlington, Grimsby, Scarborough, and Whitby, inland urban areas including Doncaster, Goole, Halifax, Selby and Wakefield where there is little development land available outside high flood risk zones, and land on the south bank of the Humber, provided the sequential test has shown that there are no suitable lower risk sites available
2. Protect parts of the strategic transport network, especially the Selby-Hull, Doncaster-York, and Doncaster-Immingham transport corridors
3. Provide flood storage, habitat creation and managed realignment in areas around the Humber, and other river corridors as required
4. Provide positive land management for flood alleviation in the upland areas of the Yorkshire Dales, the North York Moors, the Howardian Hills and the Pennines.

3.4 Local Planning Policy

3.4.1 Leeds Unitary Development Plan Review 2006

77. The Leeds Unitary Development Plan sets out the Council's proposals for the development and use of land within Leeds. The UDP was originally adopted in 2001 with a review document adopted in July 2006. The UDP will eventually be replaced by the emerging Local Development Framework.

[5] Please be aware that, at the time of writing, specific details regarding the suggested EA changes to RSS policy were not available for inclusion in the SFRA

78. With respect to flooding and climate change the UDP considers that, *"uncertainties over possible climate change make the need to safeguard floodplain areas and ensure that they are unhindered in their natural purposes particularly important*."

79. More specifically Policy N38A states that "*Development, including change of use, will not be permitted in the functional floodplain including all washland areas as identified on the proposals map unless it is for:*

    i. *Appropriate open recreation, sport, amenity and conservation uses, and*
    ii. *Essential transport and utilities infrastructure which cannot practicably be located elsewhere,*
    iii. *Development in the indicative flood plain will be assessed in accordance with the Sequential Test set out in PPG25,*
    iv. *All development should ensure that it does not increase the risk of flooding both on-site and elsewhere, catchment wide,*
    v. *In all cases early developer consultation with the Environment Agency is encouraged".*

    Generally this policy is implemented by development control officers by requiring new development to ensure equivalent to a Greenfield run-off of approximately 5L/s hectare (subject to a practical minimum figure). However, this policy is flexible dependant on site location, historical flows from the site, and downstream capacity of receiving watercourses.

80. Policy N38B places a requirement on developers to submit a Flood Risk Assessment alongside planning applications where required. These should take account of the risks of flooding, standards of existing defences, the impact of climate change and the potential to improve flood defences.

81. A thorough review of Policy N38A is recommended in response to the recent release of PPS25, and the findings and recommendations of the Leeds City Council SFRA. This is likely to be done in the Environment Development Plan Document which will be commencing preparation in April 2009.

82. Leeds City Council have produced a proposals map to accompany their UDP showing areas of Washland N38. The Strategic Flood Risk Assessment incorporates these dedicated washland areas wholly into the designation of Zone 3b Functional Floodplain under PPS25.

3.4.2 Supplementary Planning Guidance - Sustainable Drainage in Leeds, July 2004

83. The supplementary planning guidance on sustainable drainage provides information for developers on the use of sustainable drainage techniques in new developments in Leeds. Sustainable drainage seeks to mimic more natural drainage processes by allowing rainfall to soak into the ground where possible or by delaying discharges off development sites. It is of particular importance when considering "… water quality, the ecology and amenity of watercourses, including canals and downstream flooding."

84. The SPD sets out a procedure for dealing with drainage issues through the planning process. It is relevant for the whole of the District, not just localities that are at risk of flooding.

3.4.3 Local Development Framework

85. Leeds City Council policy framework is being developed within the Local Development Framework (LDF), in accordance with Section 15 of the Planning and Compulsory Purchase Act 2004.

86. At present the documents that the Council is progressing are the Core Strategy, Area Action Plans for Leeds City Centre, The Aire Valley, East and South East Leeds and the

West Leeds Gateway and a Natural Resources and Waste Development Plan Document. The Area Action Plans include specific site allocations and therefore will need to use the SFRA to carry out a Sequential Test on the proposals within them. The Council has agreed with the Environment Agency that it will be appropriate to carry out the Sequential Test within the Area Action Plan area. Where the sequential test shows that building in high flood risk areas is necessary, then it may be appropriate for the AAP to seek developer contributions to fund strategic flood defences. Specific policy should also be included to help mitigate the overall flood risk in an area, in terms of using porous surfaces, providing open spaces and using sustainable urban drainage.

87. All the Council's Development Plan Documents are subjected to sustainability appraisal and a set of sustainability objectives have been produced to support this process. Flood risk forms an integral part of the sustainability appraisal and is covered under sustainability appraisal objective SA14 which states "*Improve Leeds' ability to manage extreme weather conditions including flood risk and climate change*". As such, this SA objective is supported by the findings of this SFRA. The SFRA will be used to help the Council identify the impacts of proposed plans against the SA objective.

4 Data Collection

4.1 Overview

88. A considerable amount of knowledge exists with respect to flood risk within the district, including (but not limited to):

    - Historical river flooding information;
    - Information relating to localised flooding issues (surface water, groundwater and/or sewer related), collated in consultation with the Council and the Environment Agency;
    - Detailed flood risk mapping;
    - Environment Agency Flood Zone Maps (September 2006);
    - Topography (LiDAR).

89. All of this data has been sourced from the Council and the Environment Agency, forming the core dataset that has informed the SFRA process. The application of this data in the delineation of zones of 'high', 'medium' and 'low' probability of flooding, and the formulation of planning and development control recommendations, is explained in Section 5. An overview of the core datasets, including their source and their applicability to the SFRA process, is outlined below.

4.2 Environment Agency Flood Zone Maps

90. The Environment Agency's Flood Map shows the natural floodplain, ignoring the presence of defences, and therefore areas potentially at risk of flooding from rivers or the sea. The Flood Map shows the area that is susceptible to a 1 in 100 (1% annual exceedance probability or AEP) chance of flooding from rivers in any one year. It also indicates the area that has a 1 in 1000 (0.1% AEP) chance of flooding from rivers and/or the sea in any given year. This is also known as the Extreme Flood Outline.

91. The Flood Map outlines have been produced from a combination of a national generalised computer model, more detailed local modelling (if available), and some historic flood event outlines. The availability of detailed modelling for the Leeds area is further discussed in Section 4.4. The Environment Agency's Flood Map provides a consistent picture of flood risk for England and Wales.

92. The Environment Agency's knowledge of the floodplain is continuously being improved by a variety of studies, detailed models, data from river flow and level monitoring stations, and actual flooding information. They have an ongoing programme of improvement, and updates are made on a quarterly basis.

93. The Flood Map for the district is provided in the adjoining overview map.

4.3 Historical Flooding

94. The District has a history of flooding from the River Aire, River Wharfe and their tributaries and therefore there is the potential for flooding to have a devastating effect upon homes and livelihood. Additionally, the River Calder floods at the southern boundary of the District. There has not been any major flooding incident from the River Aire within Leeds since 1946 (previous major events being 1866 and 1775), although in 2000, 2002, and most recently in July 2007, there were near-misses for the central area of the City. However, parts of Methley, located between the Aire and Calder, were badly flooded in 1960. The River Wharfe has flooded at Otley on a number of occasions (including 2000, 1982, 1975, 1965, 1935, 1866, and 1775) and at the other settlements along the river.

95. Flood risk within the District is not restricted solely to the River Aire, River Wharfe and their tributaries, since a number of properties and locations have been affected historically as a result of localised run-off, groundwater flooding and/or failure of the underground sewer system. On 12th August 2004, an extreme event caused serious flooding of several hundred dwellings in several parts of east Leeds. Most of this flooding was from artificial drainage system surcharge and overland flow, but approximately 50 homes were flooded internally due to the flooding of Wyke Beck. On 3rd May 2005 another severe rainfall event led to the flooding of properties from Wyke Beck and from sewer systems in its vicinity. During May 2005, there was serious flooding from Farnley Wood Beck and other watercourses in south-west Leeds.

96. During the development of the Leeds City Council SFRA, in July 2007, a period of prolonged and heavy rainfall across North East England resulted in widespread flooding throughout Yorkshire. Many areas within the District of Leeds were affected by river flooding from the tributaries of the River Wharfe and the River Aire, as well as surface water flooding, resulting in the inundation of more than 300 properties. At the time of writing, the Environment Agency is collating survey data to record the level to which the rivers rose, based upon the debris left behind following the flooding. It is recommended that this information, in addition to observed data collated by Leeds City Council, is captured (and analysed) in the next review of the SFRA.

97. Detailed discussions have been held with the Council to identify those areas within Leeds that are known to have been exposed to flooding in recent years. These are discussed in more detail in Section 5.4.2. It is clear that, in some areas, the cause of flooding has been mitigated through dedicated investment in maintenance and improvement works.

98. Those areas known to have been susceptible to localised flooding in recent years have been highlighted in the overview map. It is important to highlight these areas as part of the SFRA as a number of these properties are situated outside of the delineated flood risk zones. These are an important reminder that the risk of flooding is not restricted purely to fluvial (river) flooding. Development control decisions must be made with due consideration to the potential impact that future development may have upon known existing flooding problems if not carefully managed.

4.4 Detailed Hydraulic Modelling

99. A number of detailed flooding investigations have been carried out by the Environment Agency throughout the district, including;

Ridings Area Team (Leeds)

River Aire ISIS Model (Oct 2004);
Wortley Beck/Millshaw Beck – Phase 2 (Oct 2004);
Wyke Beck – Phase 2 (Jun 2006);
River Aire Leeds Flood Alleviation Scheme Model (Oct 2005);
Upper Aire Strategy Model (Jul 2005);

Dales Area Team (York)

Firgreen Beck (Sep 2003);
Collingham Beck (Dec 2002);
Cock Beck (Jan 2002);
River Wharfe (Jan 2002);
Hol Beck (May 2004);
Hay Dike (Jan 2002);
Gill Beck (Jul 1999); and
Keswick Beck (Jul 1999)

100. These studies generally incorporate the development of a detailed hydraulic model, providing a more robust understanding of the localised fluvial flooding regime in line with Section 105 (2) of the Water Resources Act 1991. The detailed model outlines for the 1 in 20 year, 1 in 100 year, and 1 in 100 year plus climate change (where available) design events was provided by the Environment Agency for all modelled systems in early 2007. This information has been used to underpin the establishment of the PPS25 flood zones within the District of Leeds. In areas where detailed modelling is not available (refer Section 5.2) reliance has been placed upon the Environment Agency Flood Zone Maps (April 2007).

101. It should be noted that these detailed hydraulic models assume 'typical' conditions within the respective river systems that are being analysed. The predicted water levels may change if the operating regimes of the rivers involved are altered (e.g. engineering works which may be implemented in the future), or the condition of the river channel is allowed to deteriorate.

4.5 Flood Defences

102. Flood defences are typically raised structures that alter natural flow patterns and prevent floodwater from entering property in times of flooding. They are generally categorised as either 'formal' or 'informal' defences. A 'formal' flood defence is a structure that is maintained by its respective owner, regardless of whether it is owned by the Environment Agency. An 'informal' flood defence is a structure that has often not been specifically built to retain floodwater, and is not maintained for this specific purpose. Boundary walls and industrial buildings situated immediately adjacent to rivers often act as informal flood defences.

103. There are very few formal defences within the District. Notwithstanding this however, parts of Leeds City Centre are protected by informal flood defences, where a variable standard of protection is provided by boundary walls and buildings. Many of these structures were not designed and/or constructed to retain water, and they are also unlikely to be maintained to ensure structural integrity. It is also unlikely that the structures form part of a continuous barrier, and as a result there are likely to be 'back door' routes for flood water to enter the city centre.

104. The raised structures that alter the path of flood waters to provide, in effect, a flood defence function are highlighted on the adjoining flood maps. A small number of these structures may result in a potential risk to life should they fail catastrophically. Typically these are structures that are over 1m in height, and are situated immediately adjacent to areas in which pedestrians could be expected to be present during a flood event. These structures include:

- River Aire (Woodbottom) - rail embankment at Woodbottom, Caverley Lane;
- River Aire - Kirkstall Forge (B6157);
- River Aire - Bridge Road to Kirkstall Junction;
- River Aire (Leeds City Centre) - Aireside Centre downstream of Wellington Road Bridge;
- River Aire (Leeds City Centre) - Victoria Bridge to Crown Point Bridge;
- River Aire (Allerton Bywater) - Boat Lane/Main Street;
- River Wharfe (Linton Ings) - grassed bund to protect golf courses;
- River Wharfe (Collingham) - grassed bund to protect houses.

4.6 Consultation

105. Consultation has formed a key part of the data collation phase for the Leeds SFRA. The following key stakeholders have been comprehensively consulted to inform the current investigation:

Leeds City Council

Planning
Consulted to identify areas under pressure for future development and/or regeneration

Development Control
Consulted to review the applicability and 'deliverability' of emerging development control recommendations within flood affected areas of the District

Drainage
Consulted to identify areas potentially at risk from river flooding and/or urban drainage flooding

Environment Agency

The Environment Agency has been consulted to source specific flood risk information to inform the development of the SFRA. In addition, the Environment Agency is a statutory consultee under PPS25 and therefore must be satisfied with the findings and recommendations for sustainable flood risk management into the future. For this reason, the Environment Agency has been consulted during the development of the SFRA to discuss potential flood risk mitigation measures and planning recommendations.

Yorkshire Water

Yorkshire Water is responsible for the management of the public sewerage system within the District. The underground drainage systems in many towns and cities of England are being progressively upgraded from the Victorian sewers. However, they often remain under capacity and subject to relatively frequent 'overload' (i.e. resulting in flooding on the surface).

Yorkshire Water was consulted to discuss the risk of localised flooding associated with the existing drainage/sewer system. Utility companies throughout England have raised a pressing concern surrounding the sensitivity of sewer flooding related information, the concern for water companies is largely the protection of householder privacy. To this end, the information provided is quite general in nature, summarising the number of properties affected by sewer flooding per suburb during a defined storm event (e.g. a rainfall event that will occur, on average, once in 10 years).

This generalised information is presented in adjoining Appendix B. It is important to recognise however that this does not enable a direct comparison to be made between areas under pressure from future development against areas that are known to be at risk as a result of the limited capacity of the existing sewer system. Furthermore, this information provides only a record of areas that are known to have flooded in the past. It does not provide a summary of sewer systems that have reached, or may be nearing, capacity within which future development may exacerbate the risk of surcharge, and consequently localised flooding.

Notwithstanding this however, experience has shown that the Utility companies will provide more specific information with respect to system capacity when consulted as part of the LDF process (i.e. with respect to specific site allocations). Given that this is the case, it is recommended that the next review of the SFRA considers responses provided by Yorkshire Water in light of the LDF consultation phase.

It is highlighted that issues associated with failures of the underground drainage/sewer systems are often generally localised, and should not preclude development. **It is essential however that careful consideration is given to any future intensification and/or redevelopment to ensure that future development does not exacerbate known existing problems.** Planning decisions should be made with due consideration to potential drainage and sewer capacity problems, and conditions should be placed upon future development to ensure that these capacity issues are rectified before development is permitted to proceed.

Communities and Local Government (CLG)

PPS25 was released in final form in December 2006, mid way through the development of the Leeds SFRA. Similarly, the Practice Guide Companion to PPS25 was released in draft form in February 2007. Whilst the underlying principles of the policy guidance did not change, some subtle modifications were made to the document, resulting in a need to seek clarity from CLG (authors of PPS25) by both the Council and the Environment Agency. CLG were consulted on a number of specific issues throughout the SFRA process, including (but not limited to) the definition of Zone 3b Functional Floodplain, and the incorporation (or otherwise) of climate change impacts within the delineation of the PPS25 flood zones. With regard to the advice from CLG, the Council and the Environment Agency have clarified the definition of functional floodplain as defined in para. 5.2.1. of this Report.

4.7 Topography

106. Within some parts of the district, detailed flood risk mapping has been carried out, providing a robust means of delineating zones of 'high', 'medium' and 'low' risk. In areas that have not been modelled to date, dependence must be placed upon the Environment Agency Flood Zone Map, which in these areas provides a relatively coarse depiction of flood risk, as explained in Section 4.2 above. Given that this is the case, a 'sensibility' check has been carried out within areas in which detailed modelling is currently not available. The primary purpose of this check is to ensure that the adopted Environment Agency Flood Zone Map is generally representative of anticipated flooding conditions.

107. In simple terms, topography provides the basis for a common sense assessment of predicted flood zone extents. Indeed it is important to ensure that the Environment Agency Flood Zone Map reflects the fact that water flows downhill, and that water levels across the river (i.e. on either bank of the river at the same location) are equal. The Environment Agency LiDAR data has been used to reflect the topography of the District. To this end, a 'sensibility' check has been carried out on previously unmodelled streams. Those streams along which detailed modelling has been made available (replacing the Environment Agency Flood Zone Map) are listed in Section 4.4. Reliance has been placed upon the Environment Agency Flood Zone Maps for all remaining rivers within the District.

5 Flood Risk in Leeds Metropolitan District

5.1 Overview

108. The northern boundary of the District is delineated by the River Wharfe. The River Aire runs through the city centre of Leeds flowing from northwest to south east of the city. Several tributaries of these two larger rivers also flow through the District. Many of the key population centres within the District are situated along these watercourses, and not surprisingly a considerable proportion of the District is affected by flooding. The Environment Agency[6] estimates that 1,500 properties and 500 businesses are at 'significant' risk of flooding (i.e. at risk of flooding with an annual probability of 1 in 75 years).

109. It is essential to recognise that although there are existing flood defences in some areas, these do not fully remove the risk of flooding to all properties within the District. In many areas, the standard of protection provided by the defences is less than 1% AEP (1 in 100 year), and there is uncertainty surrounding the structural integrity of the defences. Furthermore, it should be recognised that there is a risk to properties as a result of localised flooding issues such as groundwater flooding, local catchment run off and/or overloading of the sewer system. These localised flooding issues affect many parts of the District, both within the fluvial flood plain and in areas of higher ground away from the flood plain.

110. Smaller watercourses and drains have been shown on the Maps. These are far more susceptible to flash flooding than the larger river systems (i.e. the River Wharfe and River Aire), responding very rapidly to localised intense rainfall. With changing climate patterns it is expected that storms of this nature will become increasingly common. It is vitally important that planning decisions recognise the potential risk that these watercourses pose to property, and that development is planned accordingly so that future sustainability can be assured.

111. The Environment Agency issues warnings of anticipated flooding from the River Aire and River Wharfe, and due to the relatively long catchment response times, substantial forewarning of a pending flood event can generally be provided. This enables the Council, emergency services, residents and businesses to prepare in an endeavour to minimise property damage and risk to life. It should however be noted that there is a low take up rate by residents and business for the Environment Agency Flood Warning scheme. Floods from the River Aire typically inundate the areas for a few days.

112. The small watercourses that form the tributaries of the larger River Aire and River Wharfe are typically flashy in nature, and due to the relatively short catchment response times, little forewarning of a pending flood event can generally be provided. Therefore the Environment Agency can not issue flood warnings, and consequently there could be a higher risk to life and property from flooding within these areas than otherwise.

113. In summary, there are a number of potential sources of flood risk affecting properties within the District. In addition to the 1,500 properties and 500 businesses identified by the Environment Agency as being at 'significant' risk of river flooding, many more are potentially at risk of localised runoff, groundwater flooding and/or sewer overload. Flooding can affect lives and livelihoods, and it is absolutely essential that future development (particularly residential development) is not placed within areas of the District within which the safety of residents cannot be assured in times of flood. The final responsibility for spatial planning decisions rests with the Local Authority.

[6] November 2006

5.2 Fluvial Flooding - Delineation of the PPS25 Flood Risk Zones

114. When examining the **risk** of a flood occurring it is also important to consider the **consequence** to the community as a direct result of the flood. PPS25 endeavours to assess the likelihood (or probability) of flooding, categorising the District into zones of low, medium and high probability. It then provides recommendations to assist the Council to manage the consequence of flooding in a sustainable manner, for example through the restriction of vulnerable development in areas of highest flood risk.

115. A key outcome of the SFRA process is the establishment of the Sequential Test in accordance with Appendix D (Table D1) of PPS25. To inform the planning process, it is necessary to review flood risk across the District, categorising land in terms of the likelihood (or probability) that flooding will occur.

116. The District has been delineated into the flood zones detailed below and these are shown on the adjoining Flood Risk Maps. It should be noted that these Flood Zones refer to the probability of flooding, ignoring the presence of formal or informal defences.

117. The delineation of the PPS25 flood zones is based upon detailed modelling outputs, where available, for the 1 in 20 year (denoting Zone 3b and Zone 3a(ii)) and 1 in 100 year (denoting Zone 3a) design events respectively. Detailed modelling results have been provided by the Environment Agency along the River Aire, the River Wharfe, and tributaries as highlighted in Section 4.4. In other areas where modelling has not been carried out to date, reliance has been placed upon the Environment Agency Flood Zone Map, as discussed in Section 4.7. The Environment Agency Flood Zone Map has been adopted as the basis for Zone 2 Medium Probability for all rivers throughout the District.

5.2.1 Delineation of Zone 3b Functional Floodplain

118. Zone 3b Functional Floodplain is defined as those areas in which *"water has to flow or be stored in times of flood"*. However the Practice Guide Companion to PPS25 gives further guidance on this definition which makes it open to subjective interpretation. Therefore, for the purposes of the Leeds SFRA , the Council, together with the Environment Agency, have sought to clarify the definition in the following manner:

- land subject to flooding in the 5% AEP (1 in 20 year) flood event, where the flow of flood water is not prevented by flood defences or by permanent buildings or other solid barriers from inundation during times of flood;
- land which provides a function of flood conveyance (i.e. free flow) or flood storage, either through natural processes, or by design (e.g. washlands and flood storage areas);
- land subject to flooding in the 5% AEP (20 year) flood event .

119. Within the District of Leeds, this encompasses primarily those low lying areas immediately adjoining the River Aire and River Wharfe. Any development within these areas is likely to measurably impact upon the existing flooding regime, increasing the severity and frequency of flooding elsewhere. Leeds City Council is committed to the protection of these areas to ensure that they are retained as natural floodplain.

120. It is noted that, within some areas of the District, existing urban development[7] is affected by flooding in the 5% AEP (1 in 20 year) event. In light of emerging guidance provided by the Practice Guide Companion to PPS25, it is reasonable to argue that these areas are not functional floodplain under the adopted PPS25 definition. Instead the site would be subject to the planning constraints posed by sites situated within the 'high' probability zone (albeit subject to more frequent flooding than the surrounding area). This is discussed further in Section 5.2.2 below.

121. Consequently the Leeds City Council adopted definition for Zone 3b (Functional Floodplain) is **land where water flows or has to be stored in times of flood, that is**

[7] including Sewage Treatment Works, and sites with the benefit of existing planning permission

subject to flooding with a 1 in 20 year probability (or more frequently), and that may be reserved by Leeds City Council for this purpose.

122. Where the Council has identified that undeveloped land already has an existing planning permission or a brownfield allocation that has been protected through the 'Saved Policies' review of the Leeds Unitary Development Plan, then a decision has been made not to include it in the functional floodplain

123. With respect to Sewage Treatment Works (STW), by their nature these are often located in areas of functional floodplain. STW are regarded in PPS25 as an inappropriate use in the functional floodplain and this could therefore pose a restraint on any possible future upgrades they may require to be able to efficiently service proposed growth in the District. The SFRA therefore draws the functional floodplain boundary around the existing STW, to ensure that they will be able to upgrade if necessary, however following decommissioning, the sites will revert to Zone 3b Functional Floodplain.

5.2.2 Delineation of Zone 3a High Probability

124. Zone 3a High Probability is defined as those areas of the District that are situated below (or within) the 1% AEP (1 in 100 year) fluvial flood extent.

125. For planning purposes, the Environment Agency has issued a series of Flood Zone Maps as depicted on the Environment Agency's website (www.environment-agency.gov.uk). Only in those areas within which detailed flood mapping is not available and/or fit for purpose, the Environment Agency's Flood Zone Maps have been adopted to underpin the SFRA process. At these locations, detailed topography has been used to carry out a 'sensibility check' of the flood zone maps. This check has sought to ensure that the predicted floodplain extents are sensible in light of surrounding ground levels. No alterations have been made to the maps in this instance.

126. The detailed modelling outputs developed by the Environment Agency, where available (refer Section 4), have been adopted for the delineation of Zone 3a High Probability, superseding the current EA flood zone map (December 2006).

Sub Delineation of Zone 3a

127. A number of areas of existing development within the District of Leeds are affected by flooding with a 5% (1 in 20 year) probability. Whilst emerging guidance confirms that these areas should not be treated as functional floodplain under PPS25, it is accepted that careful consideration must be given to the future sustainability of development within areas that may be subject to flooding on a relatively frequent basis. For this reason, Zone 3a High Probability has been sub delineated in the following manner:
    - Zone 3a(ii) High Probability - areas that fall within the 5% (1 in 20 year) flood envelope; and
    - Zone 3a(i) High Probability - areas that fall outside of the 5% (1 in 20 year) flood envelope, however are affected by flooding in the 1% (1 in 100 year) event.

    Areas of zone 3a(ii) can flood with the same frequency as functional floodplain however the Council recognises that as built development is already there, or is imminent through an existing planning permission or brownfield allocation which has been through the 'Saved policies' Review of the Leeds Unitary Development Plan, then the whole site cannot perform a function as storage space for flood water. However in the redevelopment of the site, the development control recommendations in section 6.4.3 and 6.4.4 should be taken into account and there must be an allowance, within the site, for some degree of flood storage. This will also be determined by the detailed Flood Risk Assessment which will be a precursor to the development of the site. It may also reveal flood issues, such as flow routes, that may prevent or pose severe challenges for proposed developments. The whole of the site should not be regarded as a developable area.

5.2.3 Delineation of Zone 2 Medium Probability

128. Zone 2 Medium Probability is defined as those areas of the District that are situated between the 0.1% AEP (1 in 1000 year) and the 1% AEP (1 in 100 year) flood extents. In this instance, Zone 2 Medium Probability is defined in accordance with the Environment Agency Flood Zone Map.

5.2.4 Delineation of Zone 1 Low Probability

129. Zone 1 Low Probability is defined as those areas of the District that are situated above (or outside of) the 0.1% AEP (1 in 1000 year) flood extent. For SFRA purposes, this incorporates all land that is outside of the shaded Zone 2 and Zone 3 flood risk areas (as defined above).

5.3 Assessment of Risk to Life (Flood Hazard)

5.3.1 Definition of Flood Hazard

130. The assessment of flood risk has thus far considered the maximum extent to which flooding will occur during a particular flood event. This provides the basis for assessing broadly the areas potentially impacted by flooding. Of equal importance is the speed with which flooding occurs as river levels rise. The inundation of floodwaters into low lying areas can pose a considerable risk to life.

131. Substantial research has been carried out internationally into the risk posed to pedestrians during flash flooding. This research has concluded that the likelihood of a person being knocked over by floodwaters is related directly to the depth of flow, and the speed with which the water is flowing. This is referred to as 'Flood Hazard'.

132. For example, if a flood flow is relatively deep but is low energy (i.e. slow moving), then an average adult will be able to remain standing. Similarly, if the flow of water is moving rapidly but is very shallow, then once again an average adult should not be put off balance. However, if the flow is both relatively deep and fast flowing, then a person will be washed off their feet, placing them at considerable risk. The risk to health and safety as a result of submerged hazards during flooding conditions (given the often murky nature of floodwaters) is also a consideration.

133. In summary, research has determined that if the product of flow depth (m) x flow velocity (m/s) is greater than or equal to $0.4m^2/s$, then an average adult is likely to be knocked off their feet. If the product of depth x velocity is greater than or equal to $0.6m^2/s$, then the average car will be washed away. These ratios have been determined through rigorous physical testing, and are widely accepted as reasonable threshold values above which it is deemed that there is a very real risk to life.

134. It is highlighted that these figures do relate to an average healthy adult. Young children and the elderly will clearly be more vulnerable, and may be at risk in shallower and/or lower energy flow. It is also essential to emphasise that this in no way is intended to suggest that a depth x velocity ratio that is less than $0.4m^2/s$ should be adopted as the sole measure of public safety during flooding conditions. Submerged hazards including, for example, exposed manholes and tripping obstacles pose an obvious risk. Flood water is typically both poor quality and low temperature, and these too pose obvious risks to public health.

135. Defra and the Environment Agency have recently collaborated to develop a document entitled 'Flood Risk to People' (FD2320 and FD2321). This provides guidance to aid in the review of flood hazard within the UK. Future detailed site based Flood Risk Assessments should make reference to these documents, and the PPS25 Practice Guide, when assessing the potential risk to life posed by flooding (and flood defence failure) as outlined below.

5.3.2 Flood Hazard due to River Aire and River Wharfe Flooding

136. The speed and depth with which the River Aire, River Wharfe and their tributaries floods the District is an important consideration. Deep, fast flowing water may potentially pose risk to life. This must be considered when planning future development.

137. A qualitative review of the river system within the District highlights that there are some tight bends in the river across which deep, fast flowing water would be expected to break out and flow overland in times of flood. These fall wholly within areas designated as Zone 3b Functional Floodplain, reinforcing the importance of protecting these areas from future development, both to preserve available floodplain storage within the River Aire and Wharfe, and to minimise the potential risk to life.

138. Notwithstanding this, the likelihood of a rapid river level rise within the River Aire and River Wharfe, and the possible rapid inundation of urban areas within the district posing a risk to life, is considered to be small. This is primarily due to the large upper contributing catchment area which allows the Environment Agency, with its current flood warning system, to provide forewarning of a pending flood event. It should be noted that the Environment Agency endeavours to meet its flood warning targets but this cannot be guaranteed, as well as there being a low take up rate to the Agency's Flood Warning Direct system.

5.3.3 Flood Hazard due to Flood Defence Failure

139. A small number of formal and informal raised defences have been identified within the district, providing localised protection against fluvial flooding. Flood defences are typically raised structures that alter natural flow patterns and prevent floodwater from entering property in times of flooding.

140. There is always a residual risk that these defences may fail, as a result of either overtopping and/or breach failure. The latter could result in rapid inundation into overbank areas behind the defence, posing a potential risk to residents, pedestrians and property that may be in the path of the floodwaters.

141. The raised defences highlighted in Section 4.5 typically all exceed 1m in height. Given that this is the case, should (in a worst case scenario) a catastrophic structural failure of one of these raised defences occur during high water levels within the river, then a wave of flood water will rapidly inundate the area immediately behind the location of the breach. This may pose a risk to life to those who happen to be standing immediately behind the defence at the time of failure.

142. A two dimensional hydraulic analysis of potential breach failure scenarios at these locations has been carried out. The breach modelling assumes that the water level in the river is close to overtopping at the point of defence failure. Upon catastrophic failure of the defence, the model then progressively inundates the land behind the defence based upon the topography of the area (defined by LiDAR). The depth and speed (velocity) of the flow is calculated as the floodwaters progress inland, providing the basis for determining the hazard posed to the community.

143. Areas within which the product of depth and velocity (d x V) exceeds $0.4m^2/s$ have been delineated as a 'rapid inundation zone', as explained in Section 5.3.1 above. This Rapid Inundation Zone is presented in the adjoining SFRA flood zone maps. There are no specific planning constraints under PPS25 that will prevent future development within these areas, however it is essential that the potential risk of defence failure is comprehensively addressed as part of the design (development control) process.

144. It is highlighted that the breach modelling has not taken into consideration the structural integrity of the defences. It is important to note that the probability of defence failure is directly proportional to the nature (construction) of the flood defence. Earthen embankments are susceptible to possible piping and/or slip failure. 'Hard' defences (e.g.

sheet pile walls) are less likely to fail in this manner, however a residual risk of overtopping and rotational failure does remain.

145. Finally, clearly a breach failure of the defences will, over a period of time, result in the inundation of a relatively large area. Following the initial 'burst' of water through the defences however (defined by the rapid inundation zone), the flood wave will be relatively shallow and is unlikely to pose a significant risk to life

5.4 Local Drainage Issues

5.4.1 General Issues

146. As discussed in Section 4.6, consultation has been carried out with the Environment Agency and the Council to identify known and/or perceived problem areas. These drainage problems may to be attributed to inundation from floodwaters from open drains and watercourses and increased overland flow due to development and/or exceptionally wet weather. In some instances these problems may be due to poor maintenance, associated with (for example) culvert blockages.

147. A considerable number of known localised problems have been identified throughout the District and these are discussed in more detail in Section 5.4.2. Often localised problems have been highlighted as an outcome of flooding experienced by local residents or businesses. It is important to note that these will not necessarily have been addressed through investment in localised flood mitigation measures to rectify the problem (e.g. culvert and/or channel improvements). As a result, the management of localised flooding will be an integral requirement of the detailed Flood Risk Assessment (to be completed by the developer).

148. Within the urban centres of the District, it is inevitable that localised flooding problems arising from under capacity drainage and/or sewer systems will occur. Input has been sought from Yorkshire Water to pinpoint known and/or perceived problem areas. Unfortunately the data received was very general in nature, providing simply a summary of the number of properties affected within a defined post code (restricted to the first three digits) in recent years. For this reason, it has not been possible to highlight precisely those combined sewer systems that are at, or nearing capacity, and therefore may pose a potential risk of localised flooding.

149. It is reiterated that issues of this nature are generally localised problems that can be addressed as part of the design process. They should therefore not influence the allocation of land for future development. Notwithstanding this however, It is essential to ensure that future development does not exacerbate existing flooding problems. Areas that are known to suffer from localised flooding are highlighted in the following section, identified in consultation with Leeds City Council (drainage). Strict planning conditions should be placed upon developers to ensure that best practice measures are implemented to mitigate any potential increase in loading upon existing drainage system(s).

150. The Environment Agency strongly advocates the use of Sustainable Drainage Systems (SUDS). A wide variety of SUDS techniques are available (refer Section 6.6.3), potentially providing both water quality and water quantity improvement benefits on a site by site basis throughout the District. Wherever possible, within brownfield areas, the developer should seek to reduce the rate of runoff from the site to greenfield runoff rates (i.e. the rate of runoff generated from the site assuming an open grassed area). Collectively, the effective application of SUDS as part of all future development will assist in reducing the risk of flooding to the District.

5.4.2 Specific Local Drainage Issues (see Appendix A for more details)

Existing Highway Culverts

There are more than 2000 culverts that pass beneath adopted highways within the district. In general terms, the nature of many of these structures and the catchment upstream of them means that they are at risk of blockage. The routine maintenance of culverts is undertaken by Leeds City Council, with maintenance priorities allocated through a risk based approach.

It should be recognised that the risk of any of these culverts becoming blocked during a flood event will always remain even with routine maintenance. Any blockage is likely to result in floodwater backing up behind the culvert, resulting in a greater depth of flooding. Furthermore, the lateral extent of floodwater could also be greater than indicated by the floodplain extents shown on the mapping provided in this SFRA.

Cotton Mill Beck

The culvert along Cotton Mill Beck in the Morley area is known to have insufficient capacity. Collapses have also occurred in some areas.

Leeds City Council has a strategic aim for total replacement of this culvert.

Farnley Wood Beck

Existing flood risk issues along this watercourse are the subject of a study currently being undertaken by the Environment Agency.

Known flooding problem areas include areas upstream of culverts in the Elland Road and Old Road areas where residential properties and industrial/commercial properties are affected at the confluence with Millshaw Beck. The latter has been identified by Yorkshire Water as a strategic issue and investigated by them.

Meanwoood Beck

The area upstream of Monkbridge Road in the Headingley area is a known flood problem area associated with the ability of flood flows to pass beneath of an existing bridge. This structure causes backing up behind the bridge, resulting in a greater depth of flooding. Furthermore, the lateral extent of floodwater could also be greater than indicated by the floodplain extents shown on the mapping provided in the SFRA report.

Areas upstream of Buslingthorpe Lane are prone to having debris tipped in them, resulting in the possibility of flooding being exacerbated if debris obstructs flood flows.

Cock Beck

Flood problems are known to exist in the Stanks Bridge area where roads and properties have been affected in the past, due to the backing up of public surface water sewers. This results in flooding of areas outside the extents of the fluvial floodplain.

Major redevelopment is proposed in this area and this has the potential to exacerbate the above flooding problems unless appropriate mitigation is put in place.

West Garforth

Existing flood risk issues within West Garforth are the subject of a study currently being undertaken by Leeds City Council. This study is one of several nationwide pilot studies being funded by Defra under the ‘Integrated Urban Drainage Pilot Studies’ initiative.

A series of culverts exist in the West Garforth area and these are known to have insufficient capacity, be in poor condition and pass through the gardens of a large number of residential properties.

Leeds City Council's land drainage policy for this catchment is to reduce flows into the drainage and sewer system from those that currently enter it, particularly from new development.

Kel Beck

Flood problem areas exist outside the extent of the fluvial floodplain along Kel Beck. Some of these are known to be result of a highway culvert being prone to blockage or lack of capacity in the Green Lane area.

New development is proposed upstream of this area and this has the potential to exacerbate the above flooding problems unless appropriate mitigation is put in place.

Rothwell

Major residential development is proposed in the Middleton area within the Oulton Beck and Throstle Carr Beck catchments. This development has needed to incorporate substantial balancing lakes to ensure that it does not exacerbate downstream flood risk.

Known flood problem exist in the Springhead Park area and low lying areas upstream of it. Public safety issues arise during flood events due the velocity and depth of flood flows.

Guiseley

Several watercourses within Guiseley are culverted and there are capacity and condition problems in some areas.

East Leeds

The surface water drainage for the EASEL redevelopment in East Leeds has been identified by Leeds City Council as a major area of concern. A strategic approach to future development is required by Leeds City Council. This will require all stakeholders (Leeds City Council, Environment Agency, Yorkshire Water and developers) to work together on an integrated drainage solution and this must be in place before the development commences.

In an extreme rainfall event, areas of East Leeds outside the fluvial floodplain are at risk of sewer surcharging. This risk was identified after the flooding of 2004 and is the subject of a joint report between Leeds City Council and Yorkshire Water (available on the LCC website). The frequency of discharge from combined sewer overflows could be affected by future development proposals in the East Leeds area if appropriate mitigation is not put in place. More critically, if the redevelopment area in Seacroft is drained on a separate system basis direct to Wyke Beck, upstream of York Road, this will cause a major increase in beck flows upstream of high flood risk areas. This is because, currently, a substantial amount of surface water from the Seacroft area only enters the beck via a CSO at Cartmell Drive (downstream of the sensitive areas).

Areas where there are known to be existing flood problems include sewered catchments in the Parkway Vale and Seacroft areas, where approximately 100 properties have been affected. Sewer flooding problems in Wykebeck Valley Road and Foundry Lane are currently being addressed by a major construction scheme.

Kippax

There are some problems with the capacity of the public sewers in the Valley Road area.

Farsley and Rodley

A series of old stone culverts exists and their location is currently unknown in several areas. It is assumed that the culverts have insufficient capacity and are in poor condition, given their age.

5.5 Groundwater Issues

151. The risk of groundwater flooding is highly variable within the District. It is heavily dependent upon local ground conditions at any particular time and the structures that have been constructed on them.

152. Groundwater flooding within the District should not normally preclude development. Notwithstanding this, it is recognised that the risks associated with groundwater flooding are not well understood, and it is important to ensure that future development is not placed at unnecessary risk.

153. In accordance with PPS25, all future development will require an appropriate Flood Risk Assessment (FRA) at the planning application stage, commensurate with the level of flood risk posed to the site. The detailed FRA should incorporate a detailed site based assessment of the potential risk of groundwater flooding to the site. The adopted design should be established accordingly, mitigating both the risk of groundwater flooding to the development itself, and the potential increase in flood risk posed to adjoining properties as a result of the proposed development.

5.6 Climate Change

154. Climate change is perceived to represent an increasing risk to low lying areas of England, and it is anticipated that the frequency and severity of flooding will change measurably within our lifetime. PPS25 (in its Appendix B) states that a 10% increase in the 1% AEP (100 year) river flow can be expected within the next 20 years, increasing to 20% within the next 100 years.

155. The detailed modelling of the River Aire system is ongoing, and at the time of writing the potential impact of climate change over the next 100 years, assuming a 20% increase in the 1% (100 year) flow, is under consideration. This information was not available for the purposes of the Leeds SFRA. Detailed modelled outlines were similarly unavailable for the River Wharfe and/or the local tributaries throughout the District.

156. In the absence of a definitive flood outline therefore, in simple terms **the anticipated extent of the 1% AEP (1 in 100 year) flood affected area in 2106 can be approximated by the current 0.1% AEP (1 in 1000 year) flood outline, i.e. Zone 2 Medium Probability. This indicates a very small increase in the number of properties at risk of flooding. Furthermore, it has been estimated that flood depths within the current Zone 3a High Probability may increase by up to 300mm as a result of climate change over the next 50 years.**

157. In planning terms, it is essential that Leeds City Council consider their response to the potential impacts of climate change within the District. **Adopting the pragmatic comparison between Zone 3a and Zone 2 above (i.e. where detailed modelling has not been carried out), it is clear that climate change will not markedly increase the extent of flooding.** For this reason, few additional areas that are currently situated outside of Zone 3 High Probability will be at risk of flooding in future years. This is an important conclusion from a spatial planning perspective. Notwithstanding this however, **those properties (and areas) that are currently at high risk of flooding may be susceptible to more frequent, more severe flooding in future years**. It is essential therefore that the development control process (influencing the design of future development within the District) carefully mitigates against the potential impact that climate change may have upon the risk of flooding to the property.

158. For this reason, all of the development control recommendations set out in Section 6.4 below require all floor levels, access routes, drainage systems and flood mitigation measures to be designed with an allowance for climate change. This provides a robust and sustainable approach to the potential impacts that climate change may have upon the District over the next 100 years, ensuring that future development is considered in light of the possible increases in flood risk over time.

159. It is emphasised that the potential impacts of climate change will affect not only the risk of flooding posed to property as a result of river flooding, but it will also potentially increase the frequency and intensity of localised storms over the District. This may exacerbate localised drainage problems. It is important therefore that the site based detailed Flood Risk Assessment (i.e. prepared by the developer at the planning application stage as outlined in Section 6) takes due consideration of climate change.

160. Finally, the Environment Agency is continually reviewing and updating their detailed flood risk modelling and mapping as part of an ongoing rolling programme of investment in data collection. Future reviews of the SFRA should assess whether further detailed information with respect to climate change may be available in light of this ongoing modelling work[8].

5.7 Residual Risk of Flooding

161. It is essential that the risk of flooding is minimised over the lifetime of the development in all instances. It is important to recognise that flood risk can never be fully mitigated, and there will always be a residual risk of flooding.

162. This residual risk is associated with a number of potential risk factors including (but not limited to):

- a flooding event that exceeds that for which the flood risk management measures have been designed;
- the structural deterioration of flood defence structures (including informal structures acting as a flood defence) over time; and/or
- general uncertainties inherent in the prediction of flooding.

163. The SFRA process has carried out a review of flood risk within the District in accordance with the PPS25 Sequential Test, identifying a number of areas that fall within Zone 3a High Probability. The modelling of flood flows and flood levels is not an exact science. There are limitations in the methodologies used for prediction, and the models developed are reliant upon observed flow data for calibration, much of which is often of questionable quality. For this reason, there are inherent uncertainties in the prediction of flood levels used in the assessment and management of flood risk.

164. It is difficult to quantify uncertainty. The adopted flood zones underpinning the Leeds SFRA are based upon the detailed flood mapping within most parts of the area adjoining the River Aire, River Wharfe and Wyke Beck. Whilst these provide a robust depiction of flood risk for specific modelled conditions, all detailed modelling requires the making of core assumptions and the use of empirical estimations relating to (for example) rainfall distribution and catchment response.

165. Taking a conservative approach for planning purposes, it is understood that the Environment Agency (North East Region) generally makes an allowance of at least 300mm for uncertainty within areas that have been modelled in some detail. The degree of uncertainty in areas reliant upon the Environment Agency's national generalised computer model will clearly be somewhat higher.

166. It is incumbent on developers to carry out a detailed Flood Risk Assessment as part of the design process. A review of uncertainty should be undertaken as an integral outcome of this more detailed investigation. A document that can be used to establish an

[8] It is highlighted that the detailed modelling of climate change impacts across the District is a very costly and time consuming exercise. A pragmatic approach is required for spatial planning (SFRA) purposes to establish whether or not the impacts of climate change are likely to broaden the area at risk of flooding over time.

appropriate uncertainty allowance for specific sites is the Environment Agency's Fluvial Freeboard Guidance Report.

6 Sustainable Management of Flood Risk

6.1 Overview

167. An ability to demonstrate 'sustainability' is a primary government objective for future development within the UK. The definition of 'sustainability' encompasses a number of important issues ranging broadly from the environment (i.e. minimising the impact upon the natural environment) to energy consumption (i.e. seeking alternative sources of energy to avoid the depletion of natural resources). Of particular importance is sustainable development within flood affected areas.

168. Recent history has shown the devastating impacts that flooding can have on lives, homes and businesses. A considerable number of people live and work within areas that are susceptible to flooding, and ideally development should be moved away from these areas over time. However, it is recognised that this is often not a practicable solution. For this reason, careful consideration must be taken of the measures that can be put into place to minimise the risk to property and life posed by flooding. These should address the flood risk not only in the short term, but throughout the lifetime of the proposed development. This is a requirement of PPS25.

169. The primary purpose of this SFRA is to inform decision making as part of the planning and development control process, taking due consideration of the scale and nature of flood risk affecting the district. Responsibility for flood risk management resides with all tiers of government, and indeed individual landowners, as outlined below.

6.2 Responsibility for Flood Risk Management

170. There is no statutory requirement for the Government to protect property against the risk of flooding. Notwithstanding this, the Government recognise the importance of safeguarding the wider community, and in doing so the economic and social well being of the nation. An overview of key responsibilities with respect to flood risk management is provided below.

171. The Regional Assembly should consider flood risk when reviewing strategic planning decisions including (for example) the provision of future housing and transport infrastructure. A Regional Flood Risk Assessment will assist with this process.

172. The Environment Agency has a statutory responsibility for flood management and defence in England. It assists the planning and development control process through the provision of information and advice regarding flood risk and flooding related issues.

173. The Local Planning Authority is responsible for carrying out a Strategic Flood Risk Assessment. The SFRA should consider the risk of flooding throughout the District and should inform the allocation of land for future development, development control policies and sustainability appraisals. Local Planning Authorities have a responsibility to consult with the Environment Agency when making planning decisions.

174. Landowners & Developers have the primary responsibility for protecting their land against the risk of flooding. They are also responsible for managing the drainage of their land such that they do not adversely impact upon adjoining properties.

6.3 Strategic Flood Risk Management - The Environment Agency

6.3.1 Overview

175. With the progressive development of urban areas along river corridors, particularly during the industrial era, a reactive approach to flood risk management evolved. As flooding occurred, walls or embankments were built to prevent inundation to developing areas.

176. The Environment Agency in more recent years has taken a strategic approach to flood risk management. The assessment and management of flood risk is carried out on a 'whole of catchment' basis. This enables the Environment Agency to review the impact that proposed defence works at a particular location may have upon flooding at other locations throughout the catchment.

177. A number of flood risk management strategies are underway within the region, encompassing many of the large river systems that influence flood risk within the Leeds district. A brief overview of these investigations is provided below.

6.3.2 Catchment Flood Management Plan (CFMP)

178. *"One of the Environment Agency 's main goals is to reduce flood risk from rivers and the sea to people, property and the natural environment by supporting and implementing government policies.*

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

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

180. *Catchment Flood Management Plans (CFMPs) are a planning tool through which the Agency aims to work in partnership with other key decision-makers within a river catchment to explore and define long term sustainable policies for flood risk management. CFMPs are a learning process to support an integrated approach to land use planning and management, and also River Basin Management Plans under the Water Framework Directive."* [9]

181. The flood risk regime within the District is heavily influenced by the River Aire, River Wharfe and their tributaries. These river systems are under careful consideration by the Environment Agency through a series of CFMPs, and resources are currently being targeted at a strategic level to ensuring that the nature and severity of flood risk throughout the wider area is broadly understood. This will enable the Environment Agency, responsible for the future management of flood risk within the area, to target future activities in a cost effective and sustainable manner.

[9] Catchment Flood Management Plans – Volume 1 (Guidance), Version 1.0, July 2004

6.3.3 Upper Aire Flood Risk Management Strategy

182. Beneath the 'umbrella' of the River Aire Catchment Flood Management Plan, the Environment Agency is considering the potential opportunities for flood risk management within the upper reaches of the River Aire (i.e. upstream of Castleford). The Upper Aire Flood Risk Management Strategy is seeking strategic solutions to reduce the risk of flooding to urban areas along the River Aire corridor, including Leeds. Potential opportunities under investigation include the optimisation of existing flood storage (washland) areas, the introduction of new flood storage areas, and the construction of raised flood walls. This Strategy will underpin the development of the Leeds Flood Alleviation Scheme (refer Section 6.3.4 below).

6.3.4 Leeds Flood Alleviation Scheme

183. The Leeds Flood Alleviation Scheme (FAS) is being developed by the Environment Agency. A number of potential flood risk management options are being considered including flood storage, channel improvements and/or raised defences. Upon completion, it is envisaged that the Leeds FAS will deliver a consistent 1% (100 year) standard of protection to Leeds City Centre.

184. Funding restrictions at a national level will heavily influence the delivery of the scheme, and at the time of writing it is estimated that commencement on site may not occur before 2016, outside of current planning timeframes. It is further highlighted that all federal funding for flood defence (delivered by the Environment Agency) is expressly provided to protect existing development. This money cannot be used to pave the way for future redevelopment of 'at risk' areas. For this reason, Leeds City Council is encouraged to investigate alternative possible funding options (e.g. EU or developer contributions) to proactively promote the delivery of a dedicated flood alleviation scheme for Leeds City Centre.

185. Notwithstanding this however, from a planning perspective, it is important to recognise that the construction of flood defences will never fully remove the risk of flooding. The residual risk of flooding will always remain, associated with (for example) a structural failure of the constructed flood defences.

186. For this reason, it is strongly recommended that the planning response to flood risk within Leeds is not modified in light of the proposed Flood Alleviation Scheme. Whilst the direct risk to property as a result of flooding from the River Aire will be reduced, this will be heavily dependant upon the long term structural integrity of the defences. Future decision making is clearly subject to change, and therefore investment in the ongoing maintenance of defences within Leeds City Centre cannot be fully assured over a 100 year period (i.e. the lifetime of the development that is anticipated within the City Centre). A pragmatic approach is necessary and, for example, raised floor levels and emergency access routes will still be required to ensure that the risk to property and life is minimised should a breach failure and/or overtopping of the proposed defence occur.

6.4 Planning & Development Control – Leeds City Council

6.4.1 Planning Solutions to Flood Risk Management

The Sequential Test

187. Historically urbanisation has evolved along river corridors, the rivers providing a critical source of water, food and energy. This leaves many areas of England with a legacy of key urban centres that, due largely to their close proximity to rivers, are at risk of flooding.

188. The ideal solution to effective and sustainable flood risk management is a planning led one, i.e. steer urban development away from areas that are susceptible to flooding. PPS25 advocates a sequential approach that will guide the planning decision making process (i.e. the allocation of sites). In simple terms, this requires planners to seek to allocate sites for future development within areas of lowest flood risk in the initial instance. Only if it can be demonstrated that there are no suitable sites within these areas should alternative sites (i.e. within areas that may potentially be at risk of flooding) be contemplated.

189. This sequential approach is referred to as **The Sequential Test**.

It is absolutely imperative to highlight that the SFRA does not attempt, and indeed cannot, fully address the requirements of the PPS25 Sequential Test. As highlighted in Section 6.4.1 it is necessary for the Council to demonstrate that sites for future development have been sought within the lowest flood risk zone (i.e. Zone 1 Low Probability). Only if it can be shown that suitable sites are not available within this zone can alternative sites be considered within the areas that are at greater risk of possible flooding (i.e. Zone 2, and finally Zone 3).

190. PPS25 stipulates permissible development types. This considers both the degree of flood risk posed to the site, and the likely vulnerability of the proposed development to damage (and indeed the risk to the lives of the site tenants) should a flood occur.

191. Wherever possible, the Council should restrict development to the permissible land uses summarised in PPS25 Appendix D (Table D2). This may involve seeking opportunities to 'swap' more vulnerable allocations at risk of flooding with areas of lesser vulnerability that are situated on higher ground. This is discussed further in Sections 6.4.2 to 6.4.6 below.

The Exception Test

192. Whilst only a relatively small proportion of the District is situated within Zone 3a High Probability, it does include parts of the City Centre, regeneration areas and free standing settlements along the River Wharfe. Prohibiting future residential development in these areas does therefore have implications for the economic welfare of the existing community and given the importance of Leeds City Centre, the wider Leeds City Region. If the Council can demonstrate that there are wider planning considerations which outweigh the flood and which mean that there are no other reasonable alternatives, then the Council and potential future developers are required to work through the **Exception Test** (PPS25 Appendix D) where applicable. For the Exception Test to be passed:

- *"It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared. If the DPD has reached the 'submission' stage, the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal;*
- *the development should be on developable, previously development land or if it is not on previously developed land, that there are no reasonable alternative sites on previously development land; and*
- *a FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and where possible, will reduce flood risk overall."*

193. The first two points set out in the Exception Test are planning considerations that must be adequately addressed. A planning solution to removing flood risk must be sought at each specific location in the initial instance, seeking to relocate the proposed allocation to an area of lower flood risk (i.e. Zone 1 Low Probability or Zone 2 Medium Probability) wherever feasible.

194. The SFRA has been developed in liaison with the Council and the Environment Agency to work through the requirements of the Sequential Test (and, where necessary, the Exception Test) within the District. It will be the responsibility of the developer (in all

instances within Zone 3a High Probability) to develop a detailed Flood Risk Assessment that can demonstrate that the Sequential Test has been applied, and (where appropriate) that the risk of flooding has been adequately addressed in accordance with PPS25. These should take into account the development control recommendations in section 6.4.

195. The management of flood risk throughout the District must be assured should development be permitted to proceed, and the SFRA has provided specific recommendations that ultimately should be adopted as planning conditions for all future development. It is the responsibility of the prospective developer to build upon these recommendations as part of a detailed Flood Risk Assessment to ensure that the specific requirements of PPS25 can be met.

196. An overview of flood risk throughout the District has been provided in Section 6.5 and adjoining flood zone maps. **Future planning decisions should consider the spatial variation in flood risk across the District, as defined by the delineated flood zone that applies at the specified site location, and apply the recommendations provided below accordingly.** It is highlighted that PPS25 applies equally to both allocated sites identified within the emerging LDF and future windfall sites.

6.4.2 Future Development within Zone 3b Functional Floodplain

A large proportion of the open space areas situated immediately adjacent to the River Aire (upstream of Leeds city centre) and the River Wharfe provide natural floodplain storage during a 1 in 20 year event. These areas have been designated as Zone 3b Functional Floodplain, and it is imperative that the planning process provides protection against future development at these locations.

Planning Recommendations – Allocation of Land for Future Development

Areas of Functional Floodplain that are currently undeveloped should be protected for flood storage purposes. Future development should be restricted to water-compatible uses and essential infrastructure that has to be there (in accordance with PPS25). Careful consideration should be given to the Council's emergency response in times of flood to ensure that public safety is not compromised.

Development Control Recommendations – Minimum Requirements

Future development, with the exception of water compatible uses and essential infrastructure, should not be permitted. The frequency and severity of flooding within these areas are such that no likely cost-effective engineered mitigation measures could be implemented to safely and effectively minimise the risk to life and property over the lifetime of the development.

6.4.3 Future Development within Zone 3a(ii) High Probability & Rapid Inundation Zone

Areas affected by Zone 3a(ii) high probability that fall within the 5% (1 in 20 year) flood envelope within the District, including the city centre, are generally situated adjacent to the many tributaries of the River Wharfe and River Aire. These watercourses are often constrained by urban development, and during extreme events (characterised by particularly heavy and prolonged rainfall), floodwaters can be expected to breakout of the river banks resulting in property inundation.

Many previously developed areas situated immediately adjacent to the River Aire fall within Zone 3a(ii) for planning purposes. Strategic sites within Zone 3a (ii) that are under pressure for redevelopment include:

- Leeds City Centre;
- Kirkstall Forge and Kirkstall Road;
- Stourton Riverside (Aire Valley AAP); and
- Hunslett Mill (Aire Valley AAP).

It is essential that the regeneration of these areas is carried out with due consideration to the relatively high risk posed to the site by flooding from the River Aire. Where sites are considered by the Local Planning Authority to be required for development (following the application of the sequential test and exceptions test) then the adopted land use, layout

and design must be in accordance with the planning and development control recommendations set out below.

Planning Recommendations – Allocation of Land for Future Development

1. Future redevelopment of previously developed land within Zone 3a(ii) High Probability should be restricted to 'less vulnerable' land uses. 'More vulnerable' land uses should be actively discouraged.
2. Future redevelopment within areas denoted as the 'rapid inundation zone' should be avoided. These areas pose a direct risk to life in case of catastrophic failure of the raised defence (informal or formal) system. Any future development within these areas must ensure that the future structural integrity of the raised flood defence can be assured throughout the lifetime of the proposed development.
3. For more vulnerable development, it will be necessary to ensure that the requirements of the Exception Test are satisfied. In planning terms, it must be demonstrated that "the development provides wider sustainability benefits to the community that outweigh flood risk". **It should be recognised that property situated within Zone 3a(ii) High Probability will be subject to frequent flooding with a 5% probability. There are clear sustainability implications to be considered in this regard, and it is highly questionable whether insurance against flooding related damages will be available / affordable in the longer term.**
4. Within residential areas, it is important to seek to increase the number of open areas for flood storage or conveyance purposes and in this respect there should be a presumption against all building extensions (including out-buildings and garages) within Zone 3a(ii) High Probability. Policy within Development Plan Documents will need to be developed to support this if it is deemed to be appropriate.
5. To satisfy the remaining criteria of the Exception Test, all development within Zone 3a(ii) High Probability (existing developed areas only) should be conditioned in accordance with the development control recommendations below.

   Sewage Treatment Works

   Leeds City Council has determined that all Sewage Treatment Works (STW) situated within the 20 year flood extent will be classified as falling with Zone 3a(ii) High Probability. This is to ensure that these critical elements of the municipal infrastructure can be upgraded in future years to meet both growing demand and increasingly challenging discharge conditions. It is essential to highlight that these sites will not be considered in light of the planning recommendations set out for previously developed areas above, and are not suitable for future redevelopment of any kind. This designation is adopted solely to permit future augmentation of the existing STW, and following decommissioning the sites will revert to Zone 3b Functional Floodplain.

Development Control Recommendations – Minimum Requirements

1. All proposed future development within Zone 3a(ii) High Probability will require a detailed Flood Risk Assessment (FRA), in accordance with the risk-based approach outlined in Section 6.6 below;
2. Where a detailed Flood Risk Assessment determines a site, or parts or it are in fact Functional Floodplain areas or flood conveyance routes, these areas shall be protected for flood storage purposes unless alternative and acceptable mitigation measures can be proposed and implemented (e.g. compensatory storage). It should be noted that in such circumstances a safe, acceptable and cost effective flood risk solution may not be found.
3. Basements will not be permitted within Zone 3a(ii) High Probability;
4. Implement SUDS to ensure that runoff from the site (post redevelopment) is not increased, and where possible reduced. Any SUDS design must take due account of groundwater and geological conditions;

5. Safe access is to be provided to enable the safe evacuation of residents and/or employees in case of flooding. This will be defined in accordance with the emerging Defra research as outlined in "Flood Risks to People" (FD2320). It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event;
6. Ensure that the proposed development does not result in an increase in maximum flood levels within adjoining properties. This may be achieved by ensuring (for example) that the existing building footprint is not increased and/or compensatory flood storage is provided within the site (or upstream)[10];
7. Floor levels must be situated above the 1% (1 in 100 year) predicted maximum flood level plus climate change, incorporating an allowance for freeboard;
8. A minimum 8m buffer zone must be provided to 'top of bank' within sites immediately adjoining the river corridor. This requirement may be negotiated with the EA in heavily constrained locations.
9. Land drainage issues must also be taken into account as detailed in section 6.4.7.

6.4.4 Future Development within Zone 3a(i) High Probability

Areas affected by Zone 3a(i) High Probability are areas that fall outside of the 5% (1 in 20 year) flood envelope, however are affected by flooding in the 1% (1 in 100 year) event within the District. These are generally situated adjacent to the many tributaries of the River Wharfe and River Aire. These watercourses are often constrained by urban development, and during extreme events (characterised by particularly heavy and prolonged rainfall), floodwaters can be expected to breakout of the river banks resulting in property inundation. Areas of Leeds city centre are also situated within Zone 3a(i), subject to flooding from the River Aire.

There are a number of strategic sites situated within Zone 3a(i) including the Tetley's Brewery site (City Centre AAP) and the Pontefract Road site (Aire Valley AAP). The decisions that drive the regeneration of these sites should be taken in light of the planning and development control recommendations set out below. It is anticipated that future windfall sites may also fall within Zone 3a(i) however, and it is imperative that the Council adopt a strong policy line within the affected areas to minimise the potential risk to property and life as a result of flooding in future years.

<u>Planning Recommendations – Allocation of Land for Future Development</u>

1. Future development within Zone 3a(i) High Probability should be restricted to 'less vulnerable' land uses, in accordance with PPS25 (Appendix D) Table D2. 'More vulnerable' land uses, including residential development, should be steered towards zones of lower flood risk (i.e. Zone 2 Medium Probability or Zone 1 Low Probability) within which suitable land may be available in adjoining character areas.
2. Where non-flood risk related planning matters dictate that 'more vulnerable' (residential) development should be considered further, it will be necessary to ensure that the requirements of the Exception Test are satisfied. In planning terms, it must be demonstrated that "the development provides wider sustainability benefits to the community that outweigh flood risk", and that "the development is on developable previously developed land, or that there are no reasonable alternative sites on previously developed land".
3. To satisfy the remaining criteria of the Exception Test, all development within Zone 3a(i) High Probability should be conditioned in accordance with the development control recommendations below.

[10] Compensatory flood storage should be located as close as practically possible to the proposed development. The Environment Agency can provide further advice in this regard

Development Control Recommendations – Minimum Requirements

1. All proposed future development within Zone 3a(i) High Probability will require a detailed Flood Risk Assessment (FRA);

2. Floor levels must be situated above the 1% (100 year) predicted maximum flood level plus climate change, incorporating an allowance for freeboard;
3. Safe access is to be provided to enable the safe evacuation of residents and/or employees in case of flooding. This will be defined in accordance with the emerging Defra research as outlined in "Flood Risks to People" (FD2320). It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event;
4. Basements are not to be utilised for habitable purposes. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% (100year) peak design plus climate change flood level;
5. Implement SUDS to ensure that runoff from the site (post redevelopment) is not increased, and where possible reduced. Any SUDS design must take due account of groundwater and geological conditions;
6. Ensure that the proposed development does not result in an increase in maximum flood levels within adjoining properties. This may be achieved by ensuring (for example) that the existing building footprint is not increased and/or compensatory flood storage is provided within the site (or upstream)[11];
7. A minimum 8m buffer zone must be provided to 'top of bank' within sites immediately adjoining the river corridor. This requirement may be negotiated with the EA in heavily constrained locations;

8. Land drainage issues must also be taken into account as detailed in section 6.4.7.

6.4.5 Future Development within Zone 2 Medium Probability

Few areas of the District fall within Zone 2 Medium Probability, a result of relatively well defined river valleys throughout the region. Consequently, strategic (allocated) future development sites are only partially affected by Zone 2, and this designation is unlikely to unduly impact upon planning decisions within Leeds. Notwithstanding this however, it is important to recognise that, whilst these areas are currently at risk of flooding in only an extreme event (i.e. a 1 in 1000 year flood event), the frequency of flooding will increase with time as a result of climate change. Due consideration of the planning recommendations set out below should therefore be taken to ensure that the risk of flooding is managed effectively over the lifetime of the proposed development.

Planning Recommendations – Allocation of Land for Future Development

1. In accordance with PPS25, land use within Zone 2 Medium Probability should be restricted to the 'water-compatible', 'less vulnerable' and 'more vulnerable' category (including residential development), or essential infrastructure, to satisfy the requirements of the Sequential Test
2. Where non-flood risk related planning matters dictate that 'highly vulnerable' development should be considered further, it will be necessary to ensure that the requirements of the Exception Test are satisfied. In planning terms, it must be demonstrated that "the development provides wider sustainability benefits to the community that outweigh flood risk", and that "the development is on developable previously developed land, or that there are no reasonable alternative sites on

[11] Compensatory flood storage should be located as close as practically possible to the proposed development. The Environment Agency can provide further advice in this regard

previously developed land". .

3. To satisfy the remaining criteria of the Exception Test, all development within Zone 2 Medium Probability should be conditioned in accordance with the development control recommendations below.

Development Control Recommendations – Minimum Requirements

1. All proposed future development within Zone 2 Medium Probability will require a Flood Risk Assessment (FRA) that is commensurate with the risk posed to the proposed development;
2. Floor levels must be situated above the 1% (100 year) predicted maximum flood level plus climate change, incorporating an allowance for freeboard;
3. Safe access is to be provided to enable the safe evacuation of residents and/or employees in case of flooding. This will be defined in accordance with the emerging Defra research as outlined in "Flood Risks to People" (FD2320). It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event;
4. Implement SUDS to ensure that runoff from the site (post redevelopment) is not increased, and where possible reduced. Any SUDS design must take due account of groundwater and geological conditions (refer Section 6.6.3)

6.4.6 Future Development within Zone 1 Low Probability

Planning Recommendations – Allocation of Land for Future Development

There are generally no flood risk related constraints placed upon the type of future development within Zone 1 Low Probability (in accordance with PPS25), however it is important to recognise that future development within this zone may adversely impact upon the existing flooding regime if not carefully managed. Flooding related issues of a localised nature may also occur within Zone 1 Low Probability. For this reason, all development should be carried out in accordance with the development control recommendation below. Within 'dry island' areas that are surrounded by a degree of flood risk, effective emergency planning measures should be in place to ensure that the risk to life is minimised in case of flooding.

Development Control Recommendations – Minimum Requirements

A Flood Risk Assessment, commensurate with the risk of flooding posed to and by the proposed development (i.e. relating solely to issues of a localised nature), will be required in compliance with PPS25 and current guidance and policy. This will involve the introduction of SUDS techniques to ensure that runoff from the site (post redevelopment) is not increased, and where possible reduced. Any SUDS design must take due account of groundwater and geological conditions and section 6.4.7 below.

6.4.7 Additional Requirements for all Future Development

197. In some parts of the District there are localised problems, many of which are in Zone 1, that are specific to particular areas of the District. Typical examples include the large number of culverts that are prone to blockage and the small watercourses and sewers (detailed in Section 5.4.2). It is possible that future development could adversely impact upon existing flood problem areas if appropriate mitigation is not put in place.

198. In an endeavour to minimise the potential adverse impacts of future development within the District, it is essential that developers carry out the following at the earliest stages of the planning application process:

1. Consultation must be undertaken with Leeds City Council's Land Drainage team, the Environment Agency and Yorkshire Water to establish whether there are any known localised flooding issues, particularly with respect to historic flooding problems, known or perceived culvert condition/capacity issues and risk/consequence of culvert blockage during flood events;

2. Mitigation may be required to ensure that flood risk in the vicinity of the development or downstream of the development is not made worse. If this is the case then appropriate mitigation must be agreed with the Land Drainage team as part of the planning application process. The Land Drainage team may require the run off rates and volumes from development to be reduced from those that presently emanate from the site.

6.5 Overview of Flood Risk

199. An overview of pressing flood risk related constraints within Leeds is provided below, however reference should be made to the detailed flood zone maps developed as part of the Leeds SFRA process. A detailed discussion of flood risk within key catchment areas throughout the District is provided in Appendix A, cross referencing the adjoining Catchment Map.

200. As explained in Section 6.4 above, it is essential that a sequential approach is taken at all stages of the planning process, steering future development towards areas of lowest risk wherever possible. If, and only if, the Sequential Test cannot be satisfied due to pressing planning constraints that outweigh the risk of flooding, future development must be conditioned in accordance with the recommendations provided in Section 6.4 for each respective PPS25 flood risk zone. Emerging developing pressures throughout the District are provided in Appendix B.

6.5.1 River Aire Corridor – Leeds City Centre

201. The River Aire is a major characteristic of Leeds City Centre, flowing through the very heart of the City. Flooding occurred recently in June 2007 and in November 2000 the river came within inches of overtopping its banks.

202. Detailed modelling of the River Aire system predicts that the likelihood of flooding within the City Centre may be as high as 10%, i.e. a 1 in 10 chance of flooding. Certainly a large proportion of the City Centre is at risk of flooding, on average, once in every 20 years (as indicated by the extent of Zone 3a(ii) High Probability). Given the pressure for future regeneration and investment within the City Centre, it is clear that careful planning decisions must be made to ensure the future sustainability of the area – and indeed the safety of future residents. It is imperative that all future development within the City Centre complies with the restrictions and design conditions set out in Section 6.4 above.

203. It is important to recognise that whilst the Environment Agency is investigating the economic viability of a possible flood alleviation scheme for Leeds City Centre, it is anticipated that it may be over a decade before this scheme is in place. Recent investigations carried out by the EA have demonstrated that there is limited scope for the provision of upstream flood storage to reduce the susceptibility to flooding within the City Centre. Rather a system of raised walls is proposed. For this reason, it is strongly recommended that future development along the River Aire is managed in such a way to ensure that a protected 'buffer' is retained, paving the way for the future construction of the flood wall.

6.5.2 River Aire Corridor – Beyond Leeds City Centre (East and West)

204. Urbanisation is relatively limited along the River Aire corridor outside of Leeds City Centre, and this is mirrored to some extent by the relatively limited pressure for future development upstream (i.e. to the west) and/or downstream (i.e. to the east) of the City. Notwithstanding this, there are a small number of key potential regeneration areas that have been earmarked for strategic centres of future development. Particular reference is made to strategic riverfront sites identified within the Aire Valley AAP. It is imperative that informed decisions are taken with due regard to the potential risk of flooding, in accordance with Section 6.4 above. This will avoid a legacy of costly (and potentially dangerous) future problems to businesses and residents of the area.

205. Once again, detailed modelling has demonstrated that the likelihood of flooding to overbank areas along the River Aire may be as high as a 1 in 5 chance of occurring in any one year. Whilst strategic studies by the EA have concluded that there is little opportunity to reduce the risk of flooding to Leeds through the provision of a dedicated flood storage facility upstream of the City Centre, it is absolutely essential that existing areas of open floodplain are protected from development to avoid any worsening of the existing level of risk.

6.5.3 River Aire Tributaries – Wider Leeds District

206. The wider District of Leeds is characterised by a relatively large number of watercourses that flow in a typically northerly or southerly direction into the River Aire, as highlighted in the adjoining Flood Zone Maps. The wider District is heavily urbanised, and as in many urban centres of England, progressive development over the years has placed considerable pressure upon local watercourses. Many of the River Aire tributaries are heavily constrained by development on both banks, and/or indeed culverting that enabled unrestricted development on top of historical waterway corridors. The result is unsurprisingly a legacy of flooding problems during heavy rain.

207. The local catchment is generally paved with roads, carparks, buildings and patio areas, and rainfall drains rapidly towards underground sewer systems. The watercourses, particularly where culverted, are often subject to blockage due to litter and general debris washing down from urban areas. This further exacerbates the risk of localised flooding, preventing local runoff from easily getting away.

208. All future development within the District has the potential to exacerbate the risk of localised flooding within Leeds. Whilst there are a large number of known problem areas, future unmitigated development will place further pressure on strained sewer systems and local watercourses, introducing additional problems that may not currently be recognised.

209. It is imperative that all future development is conditioned in accordance with the constraints identified in Section 6.4 above. Relatively few areas are directly at risk of flooding from rivers and watercourses however, and therefore particular attention must be given to the additional requirements stipulated in Section 6.4.7 to ensure that localised problems within the District are not made worse by unmitigated development placing further pressure upon already constrained drainage systems.

210. Wherever possible, it is recommended that opportunities are sought to protect and retain open (undeveloped) waterway corridors along the tributaries of the River Aire.

6.5.4 River Wharfe Corridor – Otley to Wetherby

211. With the exception of the key centres of Otley and Wetherby, the River Wharfe corridor is relatively undeveloped, however there are a number of smaller settlements such as Boston Spa and Collingham Bridge located along its banks. These settlements are important as places where people live and the Council is committed to ensuring their sustainability.

212. Localised areas of existing urban development within Otley and Wetherby are at risk of flooding from the River Wharfe, and it is essential that all future planning decisions are guided by the recommendations provided in Section 6.4 above. Existing floodplain areas should be protected through the planning process to avoid any future exacerbation of flooding to ‘at risk’ areas.

6.6 Detailed Flood Risk Assessment (FRA) – The Developer

6.6.1 Scope of the Detailed Flood Risk Assessment

213. As highlighted in Section 2, the SFRA is a strategic document that provides an overview of flood risk throughout the area. It is imperative that a site-based Flood Risk Assessment (FRA) is carried out by the developer for all proposed developments, and this should be submitted as an integral part of the planning application.

214. The FRA should be commensurate with the risk of flooding to the proposed development. For example, where the risk of fluvial flooding to the site is negligible (e.g. Zone 1 Low Probability), there is little benefit to be gained in assessing the potential risk to life and/or property as a result of flooding. Rather, emphasis should be placed on ensuring that runoff from the site does not exacerbate flooding lower in the catchment. The particular requirements for FRAs within each delineated flood zone are outlined below.

It is highlighted that the description of flood risk provided in the discussions above place emphasis upon the primary source of flood risk (i.e. river flooding). In all areas, a localised risk of flooding may also occur, typically associated with local catchment runoff following intense rainfall passing directly over the District. This localised risk of flooding must also be considered as an integral part of the detailed Flood Risk Assessment.

215. To assist local planning authorities, the Environment Agency has produced standing advice to inform on their requirements regarding the consultation process for planning applications on flood risk matters. Full details of their Flood Risk Standing Advice can be found on the website: *www.pipernetworking.com*. One such requirement is for the Environment Agency to be consulted by the Local Planning Authority for planning applications for development within 20 metres from the top of the bank/wall of a main river.

216. Proposed Development within Zone 3a(i) High Probability & Zone 3a(ii) High Probability (existing developed areas)

All FRAs supporting proposed development within Zone 3a(i) and Zone 3a(ii) High Probability should include an assessment of the following:

- The vulnerability of the development to flooding from other sources (e.g. surface water drainage, groundwater) as well as from river flooding. This will involve discussion with the Council and the Environment Agency to confirm whether a localised risk of flooding exists at the proposed site.
- The vulnerability of the development to flooding over the lifetime of the development (including the potential impacts of climate change), i.e. maximum water levels, flow paths and flood extents within the property and surrounding area. The Environment Agency may have carried out detailed flood risk mapping within localised areas that could be used to underpin this assessment. Where available, this will be provided at a cost to the developer. Where detailed modelling is not available, hydraulic modelling by suitably qualified engineers will be required to determine the risk of flooding to the site.
- The potential of the development to increase flood risk elsewhere through the addition of hard surfaces, the effect of the new development on surface water runoff, and the effect of the new development on depth and speed of flooding to adjacent and surrounding property. This will require a detailed assessment, to be carried out by a suitably qualified engineer.
- A demonstration that residual risks of flooding (after existing and proposed flood management and mitigation measures are taken into account) are acceptable. Measures may include flood defences, flood resistant and resilient design, escape/evacuation, effective flood warning and emergency planning.
- Details of existing site levels, proposed site levels and proposed ground floor levels. All levels should be stated relevant to Ordnance Datum.

- The effects of climate change on flood levels (see section 5.6)

217. It is noted that a proportion of the District is delineated as Zone 3a High Probability, however, the presence of localised raised defences provides a degree of protection against flooding in some areas. It is broadly accepted that these defences reduce the actual risk to properties, however, recent history has demonstrated the potentially catastrophic consequence of a breach failure.

218. It is essential that developers thoroughly review the existing and future structural integrity of the defences (i.e. over the lifetime of the development), and ensure that emergency planning measures are in place to minimise risk to life in the unlikely event of a defence failure.

219. Proposed Development within Zone 2 Medium Probability

- For all sites within Zone 2 Medium Probability, a high level FRA should be prepared based upon readily available existing flooding information, sourced from the EA. It will be necessary to demonstrate that the residual risk of flooding to the property is effectively managed through, for example, the provision of raised floor levels (refer Section 6.6.2) and the provision of a planned evacuation route and/or safe haven.
- The risk of alternative sources of flooding (e.g. urban drainage and/or groundwater) must be considered, and sustainable urban drainage techniques must be employed to ensure no worsening to existing flooding problems elsewhere within the area.

220. Proposed Development within Zone 1 Low Probability

For all sites situated within Zone 1 Low Probability, a high level Flood Risk Assessment must be prepared. Where the proposed development exceeds 1ha in area, the EA must be consulted.

The FRA should be commensurate with the nature of the flood risk posed to, and by, the development of the site, and in most areas this will involve a relatively simple assessment of issues of a localised nature. The risk of alternative sources of flooding (e.g. urban drainage and/or groundwater) must be considered. Details of proposed sustainable drainage systems (SuDS) that will be implemented to ensure that runoff from the site (post redevelopment) is not increased. Any SuDS design must take due account of groundwater and geological conditions. Specific reference is drawn to the requirements of Section 6.4.7 above.

221. The SFRA provides specific recommendations with respect to the provision of sustainable flood risk mitigation opportunities that will address both the risk to life and the residual risk of flooding to development within particular 'zones' of the area. These recommendations should form the basis for the site-based FRA.

6.6.2 Raised Floor Levels & Basements (Freeboard)

222. The raising of floor levels above the 1% AEP (1 in 100 year) fluvial flood level will ensure that the damage to property is minimised. Given the anticipated increase in flood levels due to climate change, the adopted floor level should be raised above the 1% AEP (1 in 100 year) predicted flood level assuming a 20% increase in flow over the next 50 years.

223. A site specific allowance should be determined as an outcome of the site based FRA. This is likely to result in floor levels being be situated a minimum of 300mm above the 1% AEP (1 in 100 year) plus climate change flood level, or 600mm above the 1% AEP (1 in 100 year) flood level if no climate change data is available. The height that the floor level is raised above flood level is referred to as the 'freeboard', and is determined as a measure of the residual risks.

224. The use of basements within flood affected areas should be discouraged. Where basement uses are permitted, it is necessary to ensure that the basement access points are situated a minimum of 300mm above the 1% AEP (1 in 100 year) flood level plus climate change. An appropriate site specific allowance should be determined as an outcome of the site based FRA. The basement must be of a waterproof construction to avoid seepage during flooding conditions. Habitable uses of basements within flood affected areas should not be permitted.

6.6.3 Sustainable Drainage Systems (SUDS)

225. SUDS is a term used to describe the various approaches that can be used to manage surface water drainage in a way that mimics the natural environment. The management of rainfall (surface water) is considered an essential element of reducing future flood risk to both the site and its surroundings. Indeed reducing the rate of discharge from urban sites to greenfield runoff rates (as described in Section 5.4) is one of the most effective ways of reducing and managing flood risk within the district. The use of SUDS is endorsed by PPS25.

226. SUDS may improve the sustainable management of water for a site by[12]:

- reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- reducing volumes and the frequency of water flowing directly to watercourses or sewers from developed sites;
- improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- reducing potable water demand through rainwater harvesting;
- improving amenity through the provision of public open space and wildlife habitat;
- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

227. In catchment terms, any reduction in the amount of water that originates from any given site is likely to be small. But if applied across the catchment in a consistent way, the cumulative affect of a number of sites could be significant.

228. The most commonly found components of a SUDS system are described in the following table[13]. The appropriate application of a SUDS scheme to a specific development must carefully consider the site characteristics as the sustainability of the system is heavily dependent upon the topography and geology of the site (and its surrounds).

Pervious surfaces	Surfaces that allow inflow of rainwater into the underlying construction or soil.
Green roofs	Vegetated roofs that reduce the volume and rate of runoff and remove pollution.
Filter drain	Linear drains consisting of trenches filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage, to store and conduct water; they may also permit infiltration.
Filter strips	Vegetated areas of gently sloping ground designed to drain water evenly off impermeable areas and to filter out silt and other particulates.
Swales	Shallow vegetated channels that conduct and retain water, and may also permit infiltration; the vegetation filters particulate matter.
Basins, Ponds and Wetlands	Areas that may be utilised for surface runoff storage.
Infiltration Devices	Sub-surface structures to promote the infiltration of surface water to ground. They can be trenches, basins or soakaways.

[12] Interim Code of Practice for Sustainable Drainage Systems National SUDS Working Group, 2004
[13] Interim Code of Practice for Sustainable Drainage Systems National SUDS Working Group, 2004

Bioretention areas	Vegetated areas designed to collect and treat water before discharge via a piped system or infiltration to the ground
Pipes and accessories	A series of conduits and their accessories normally laid underground that convey surface water to a suitable location for treatment and/or disposal. (Although sustainable, these techniques should be considered where other SUDS techniques are not practicable).

229. For more guidance on SUDS, the following documents and websites are recommended as a starting point:

- Interim Code of Practice for Sustainable Drainage Systems, National SUDS Working Group, 2004
- Draft Planning Policy Statement 25, Annex F, Office of the Deputy Prime Minister, 2005
- www.ciria.org.uk/SUDS/

6.7 Local Community Actions to Reduce Flood Damage

230. It is estimated by the Environment Agency that over 1,500 properties and 500 businesses within the District are at 'significant' risk of flooding (i.e. affected by flooding in events up to and including the 1% AEP (100 year) event). It is essential therefore to ensure a broad awareness with respect to flood risk, providing the community with the knowledge (and tools) that will enable them to help themselves should a flood event occur.

231. The following 'community based measures' are cost effective solutions that local communities may introduce to minimise the damage sustained to their own homes in the case of flooding.

6.7.1 Flood Proofing

232. The 'flood proofing' of a property may take a variety of forms:

For new homes and/or during redevelopment

- Raising of floor levels
  The raising of floor levels above the anticipated maximum flood level ensures that the interior of the property is not directly affected by flooding, avoiding damage to furnishings, wiring and interior walls. It is highlighted that plumbing may still be impacted as a result of mains sewer failure.

- Raising of electrical wiring
  The raising of electrical wiring and sockets within flood affected buildings reduces the risks to health and safety, and reduces the time required after a flood to rectify the damages sustained.

For existing homes

- Flood boards

The placement of a temporary watertight seal across doors, windows and air bricks to avoid inundation of the building interior. This may be suitable for relatively short periods of flooding, however, the porosity of brickwork may result in damage being sustained should water levels remain elevated for an extended period of time. This may lessen the effectiveness of flood proofing to existing properties affected by flooding from larger river systems such as the River Aire and River Wharfe.

6.8 Emergency Planning

233. The Council is designated as a Category 1 Responder under the Civil Contingencies Act 2004. As such, the Council has defined responsibilities to assess risk, and respond appropriately in case of an emergency, including (for example) a major flooding event. The Council's primary responsibilities are[14]:
    a. *from time to time assess the risk of an emergency occurring;*
    b. *from time to time assess the risk of an emergency making it necessary or expedient for the person or body to perform any of his or its functions;*
    c. *maintain plans for the purpose of ensuring, so far as is reasonably practicable, that if an emergency occurs the person or body is able to continue to perform his or its functions;*
    d. *maintain plans for the purpose of ensuring that if an emergency occurs or is likely to occur the person or body is able to perform his or its functions so far as necessary or desirable for the purpose of:*
        i. *preventing the emergency,*
        ii. *reducing, controlling or mitigating its effects, or*
        iii. *taking other action in connection with it*

234. The SFRA provides a concise summary of the possible sources of flooding within the District, and may be used to inform the assessment of flood risk in response to the requirements of the Act.

235. The Environment Agency monitors river levels within a number of the main rivers affecting the District, including the River Wharfe and the River Aire. Based upon weather predictions provided by the Met Office, the Agency makes an assessment of the anticipated maximum water level that is likely to be reached within the proceeding hours (and/or days). Where these predicted water levels are expected to result in the inundation of populated areas[15], the Environment Agency will issue a series of flood warnings within defined flood warning areas, encouraging residents to take action to avoid or minimize damage to property.

236. As water levels rise and begin to pose a risk to life and/or livelihood, it is the responsibility of the emergency services to coordinate the evacuation of residents. It is essential that a robust generic plan is in place that clearly sets out (as a minimum):
    - roles and responsibilities;
    - paths of communication;
    - rest centres to house evacuated residents;
    - contingency plans in case of loss of power and/or communication.

237. Co-ordination between the emergency services, local authority and the Environment Agency is imperative to ensure the safety of residents in time of flood. Areas within the District that are adjoining the River Aire and the River Wharfe, and are at risk of river flooding (as indicated by the shaded PPS25 flood risk zones in the adjoining maps), are often susceptible to relatively long duration rainfall events, and considerable forewarning will generally be provided to encourage preparation in an effort to minimise property damage and risk to life. It is important to recognise however that few households within the District have registered with the Environment Agency to receive flood warnings, and therefore the current effectiveness of the system is heavily compromised.

238. In contrast, areas suffering from localised flooding issues (and areas at risk of flooding from the smaller tributaries of the main rivers) will tend to be susceptible to 'flash' flooding, associated with storm cells that pass over the district. Storms of this nature result in high intensity, often relatively localised, rainfall. It is anticipated that events of this nature will occur more often as a result of possible climate change over the coming decades. Events of this nature are difficult to predict accurately, and the rapid runoff that follows will often result in flooding that cannot be sensibly forewarned.

[14] Civil Contingencies Act 2004
[15] Restricted to those urban areas situated within Environment Agency flood warning zones

239. All urbanised areas are potentially at some degree risk of localised flooding due to heavy rainfall. The blockage of gullies and culverts as a result of litter and/or leaves is commonplace, and this will inevitably lead to localised problems that can only realistically be addressed by reactive maintenance.

240. It is important to recognise that future planning decisions may alter the risk of flooding to people and property within the District, introducing (and/or removing) properties from areas that are potentially at risk of flooding. These decisions may therefore impact upon the emergency response required during periods of flooding in future years.

241. Notwithstanding this, it is very important to recognise that the river flooding depicted within the adjoining flood risk maps is unlikely to occur in isolation. Flooding of this nature will typically occur during heavy, prolonged rainfall across the District, and is likely to coincide with other emergency incidents, for example localised flooding due to sewer failure.

6.9 Insurance

242. Many residents and business owners perceive insurance to be a final safeguard should damages be sustained as a result of a natural disaster such as flooding. Considerable media interest followed the widespread flooding of 2000 when it became clear that the insurance industry were rigorously reviewing their approach to providing insurance protection to homes and businesses situated within flood affected areas. Not surprisingly, the recent widespread flooding of June 2007 has further exacerbated the discussion surrounding the future of insurance for householders and business owners situated within flood affected areas.

243. The following quotations are an extract from the Association of British Insurers (ABI) website, dated August 2007:

> *"The UK is unique in offering flood cover as a standard feature of household and most business policies. Unlike much of Europe and worldwide, cover is widely available to the UK's 23.5 million householders.*
>
> *In the long term, this situation could worsen, unless we take action to reduce flood risk to people and property. Climate change will increase winter rainfall, the frequency of heavy rainfall, and sea levels and storm surge heights. With no change in Government policies or spending, climate change could increase the number of properties at risk of flooding to 3.5 million. Furthermore, continued pressure on land could mean even more new developments being situated in floodplains.*
>
> *By spreading the risk across policy holders, insurance enables householders and businesses to minimize the financial cost of damage from flooding. In the modern competitive insurance market, premiums reflect the risks that customers face. This enables insurance to be offered at very competitive prices to customers living in low flood risk areas.*
>
> *In 2003 ABI members agreed to extend their commitment to provide flood insurance to the vast majority of UK customers. The result of discussions between Government and insurers was a Statement of Principles, which aims to provide reassurance to the overwhelming majority of insurance customers living in the floodplain about the continued availability of insurance in future.*
>
> *Individual property owners can do much to increase the resistance and resilience of their properties to flood damage - further information is available. ABI has issued a factsheet for property owners on a range of measures that could be taken by a homeowner to improve the resilience of their property to flood damage."*

244. In summary, for the time being, residents and business owners can be assured that insurance will be available to assist in recovery following a flood event. However there is the potential for substantial premiums and flooding excess fees. The future availability of flood insurance within the UK will be heavily dependant upon commitment from the government to reduce the risk of flooding over time, particularly given the anticipated impacts of climate change. Investment is required in flood defence and improving the capacity of sewage and drainage infrastructure, however it is also essential to ensure that spatial planning decisions do not unnecessarily place property within areas at risk of flooding.

7 Conclusion & Recommendations

245. A considerable number of properties within the District of Leeds are at risk of flooding, arising from a number of sources including river flooding, localised runoff and sewer flooding. Over 2000 properties within the District are potentially at risk from river flooding and this is further exacerbated by the fact that Leeds is predominantly a large built up area which in turn increases the speed of surface water runoff. In the long term, climate change is likely to slightly increase the number of properties within zone 2, as well as increase flood depths in zone 3.

246. A planning solution to flood risk management should be sought wherever possible, steering vulnerable development away from areas affected by flooding by application of the Sequential Test. The SFRA is a useful tool in this process because it collates information on all sources of flooding in the District and therefore provides a sound evidence base to enable planning decisions to be made.

247. The District has been broken down into zones of 'high', 'medium' and 'low' probability of flooding in accordance with PPS25. Parts of the City Centre, regeneration areas and out-lying settlements are within the zone 3a high probability area and therefore there is a need to balance avoiding flood risk with ensuring the viability of such areas. The SFRA further sub-divides zone 3a into 3a(ii) with a 1 in 20 year flood probability and zone 3a(i) with a 1 in 100 year flood probability. This allows a greater refinement of policy recommendations and so enables the Council to manage the risk better. In applying the Sequential Test to the allocation of land for development, the sub-delineation of zone 3a means that where it is not possible to find reasonable alternative sites for development in lower flood risk zones then it may be possible to at least find sites within the lowest part of zone 3a (ie. zone 3a(i). Likewise, in terms of the application of the Sequential Test at development control stage, the sub-division of the zone means that developers can apply the sequential approach **within** a site, from an early stage in the development process. This means that the 'more vulnerable' uses can be located in the least risk parts of a mixed use site.

248. Where the Sequential Test has been met, specific recommendations have been provided to assist the Council and the developer to meet the Exception Test ie. to ensure that the development will be safe without increasing flood risk elsewhere. These are listed as development control recommendations in Section 6.5. Where a site is in zone 3a(ii) it will flood with the same frequency as the functional floodplain and therefore a degree of flood storage is likely to be required within the site. It is therefore important NOT to regard the whole of the site as the developable area. It may be possible that on such sites a safe solution to flood risk cannot be found.

249. The Council has a requirement to ensure that sufficient land is allocated in the District to accommodate the levels of housing growth indicated in the Regional Spatial Strategy. This may necessitate difficult choices to be made about whether to locate housing in flood risk areas in order to accommodate development. This will be a matter for the Core Strategy. However, it is essential that the Council gives full consideration to the sustainability implications of a decision to allocate sites for housing development in high flood risk areas.

250. Emergency planning is imperative to minimise the risk to life posed by flooding within the District. Decisions that are made on the location of future housing and employment growth in flood risk areas could create an added burden on emergency planning, as they generate the need for further emergency plans and complicate particular considerations such as evacuations. It is essential that consultation with the Council's Risk and Emergency Planning Unit is carried out whenever new development is proposed in flood risk locations.

251. Even where development takes place on land where there is no probability of flood risk, it is important to consider the impact that such sites can have on increasing surface water runoff and thereby exacerbating flood risk. Smaller watercourses and drains are far more

susceptible to flash flooding than the larger river systems (i.e. the River Wharfe and River Aire), responding very rapidly to localised intense rainfall. With changing climate patterns it is expected that storms of this nature will become increasingly common. It is vitally important that planning decisions recognise the potential risk that these watercourses pose to property, and that development is planned accordingly so that future sustainability can be assured. The Core Strategy and Area Action Plans should include policies to require development to reduce the rate and/or volume of runoff into local waterways.

252. If the Council considers it to be appropriate, it may be necessary to develop policy within Development Plan Documents to remove permitted development rights in specific areas upstream of sites which are known to be at high flood risk. This is to ensure that residential areas retain the open spaces that form gardens and curtilages as far as possible. This will help to control the development of extensions and garages where the Local Planning Authority considers that they may contribute to increased surface water runoff and enable open spaces to continue to provide a valuable local flood storage function.

A Living Document

253. The SFRA has been developed building heavily upon existing knowledge with respect to flood risk within the district. A rolling programme of detailed flood risk mapping within the North East region is underway. This, in addition to observed flooding that may occur throughout a year, will improve the current knowledge of flood risk within the District and may marginally alter predicted flood extents within Leeds. Furthermore, Communities and Local Government (CLG) are working to provide further detailed advice with respect to the application of PPS25, and future amendments to the PPS25 Practice Guide are anticipated. Given that this is the case, a periodic review of the Leeds City Council SFRA is imperative.

254. Additionally, as detailed Flood Risk Assessments are carried out, these will identify new areas of functional floodplain which can then be added to the SFRA Flood Risk Maps.

255. It is recommended that the Leeds City Council SFRA is reviewed once every 12 months, commencing in July 2008. The following key questions should be addressed as part of the SFRA review process:

Question 1

Has any flooding been observed within the District since the previous review? If so, the following information should be captured as an addendum to the SFRA:

- What was the mapped extent of the flooding?
- On what date did the flooding occur?
- What was the perceived cause of the flooding?
- If possible, what was the indicative statistical probability of the observed flooding event? (i.e. how often, on average, would an event of that magnitude be observed within the District?)
- If the flooding was caused by overtopping of the riverbanks, are the observed flood extents situated outside of the current Zone 3a? If it is estimated that the frequency of flooding does not exceed, on average, once in every 100 years then the flooded areas (from the river) should be incorporated into Zone 3a to inform future planning decision making.

NOTE- Appendix B will require updating as YW's capital programme is likely to result in properties being removed from the Flood Risk Register.

Question 2

Have any amendments to PPS25 or the Practice Companion Guide been released since the previous review? If so, the following key questions should be tested:

- Does the revision to the policy guidance alter the definition of the PPS25 Flood Zones presented within the SFRA? (refer Section 5.2)

- Does the revision to the policy guidance alter the decision making process required to satisfy the Sequential Test? (refer Section 6.4.1)
- Does the revision to the policy guidance alter the application of the Exception Test? (refer Section 6.4.1)
- Does the revision to the policy guidance alter the categorisation of land use vulnerability, presented within Table D2 of PPS25 (December 2006)?

If the answer to any of these core questions is 'yes' then a review of the SFRA recommendations in light of the identified policy change should be carried out.

Question 3
Has the Environment Agency issued any amendments to their flood risk mapping and/or standing guidance since the previous policy review? If so:

- Has any further detailed flood risk mapping been completed within the District, resulting in a change to the 20 year, 100 year or 1000 year flood outline? If yes, then the Zone 3b and Zone 3a flood outlines should be updated accordingly.
- Has the assessment of the impacts that climate change may have upon rainfall and/or river flows over time altered? (refer Section 5.6) If yes, then a review of the impacts that climate change may have upon the District is required.
- Do the development control recommendations provided in Section 6.4 of the SFRA in any way contradict emerging EA advice with respect to (for example) the provision of emergency access, the setting of floor levels and the integration of sustainable drainage techniques? If yes, then a discussion with the EA is required to ensure an agreed suite of development control requirements are in place.

It is highlighted that the Environment Agency review the Flood Zone Map on a quarterly basis. If this has been revised within the District, the updated Flood Zones will be automatically forwarded to the Council for their reference. *It is recommended that only those areas that have been amended by the Environment Agency since the previous SFRA review are reflected in Zone 3 and Zone 2 of the SFRA flood maps.* This ensures that the more rigorous analyses carried out as part of the SFRA process are not inadvertently lost by a simple global replacement of the SFRA flood maps with the Flood Zone Maps. .

Question 4
Has the implementation of the SFRA within the spatial planning and/or development control functions of the Council raised any particular issues or concerns that need to be reviewed as part of the SFRA process?

SFRA Limitations

The Leeds City Council SFRA has been developed based upon the best available information at the time of publication (September 2007). It is essential to recognise that all recommendations and assumptions have been made on the basis of this data, and as improved information comes to light, these may be subject to change.

Within areas where detailed flood risk mapping is not available, reliance has been placed upon the Environment Agency Flood Zone Map (April 2007). The SFRA mapping reflects the waterway centreline information provided by the Environment Agency for main rivers, ordinary watercourses, and culverts. At some locations, it is evident that there is a slight mismatch between the EA Flood Zone outline and the waterway centreline. This may reflect a slight error in the predicted flooding extents or waterway alignment. It may also indicate an overland flow path that directs water away from the main carrier as floodwaters break out of the channel (for example, in culverted reaches).

The information provided in the adjoining SFRA maps is intended purely to inform strategic planning decisions. It will always be necessary to rigorously review this

information on a local scale as part of a detailed Flood Risk Assessment at the planning application stage.

Appendix A

Detailed Discussion of Flood Risk within Leeds District (refer Catchment Map)

River Wharfe (upper), Kel Beck and Hol Beck Catchments

Review of Flood Risk

Detailed flood risk modelling of the River Wharfe has been carried out by the Environment Agency, and this has been used to underpin the SFRA in this instance. There is a considerable area of low lying land immediately adjoining the River Wharfe corridor that is susceptible to relatively frequent river flooding. These areas are currently undeveloped, and it is essential that these important floodplain areas are protected against future development.

There is no evident risk of river flooding within the relatively steep Kel Beck and Hol Beck catchments, situated immediately to the north of the River Wharfe (encompassing the village of Newall). Notwithstanding this however, there is a considerable record of localised flooding issues within Newall, largely associated with the blockage of culverts along both Beck corridors. Similarly, localised flooding problems have been known to result from Kel Beck in the Green Lane area due to highway culvert blockages or a lack of capacity.

To reduce the susceptibility of localised flooding, regular, proactive maintenance is required to keep local waterway corridors clear of debris. It is essential that future development does not increase the rate and/or volume of runoff into the local waterways. Future redevelopment within the catchment must implement sustainable drainage techniques, including (for example) infiltration and/or water harvesting, to limit the rate of runoff to the Greenfield equivalent.

It is important to consider the local topography and geology when designing SuDS. The relatively steep topography at this location is an important consideration in this instance, and this may reduce the effectiveness of SuDS if not carefully considered, designing the drainage system accordingly. Finally, within these steep upper reaches of the River Wharfe catchment, it is inevitable that overland flow (i.e. flow that exceeds the capacity of the designed drainage system) will occur following heavy rainfall. Development should be designed to ensure that 'natural' flow paths are not obstructed by buildings and/or landscaping.

Development Pressure

Residential development is proposed at Rumplecroft, upstream of Kel Beck which has the potential to exacerbate localised flooding problems if appropriate mitigation measures are not put in place. Planning permission has been granted for a mixed use development at Garnetts Mill immediately adjacent to the River Wharfe which is mostly in flood zone 2 medium risk but parts of the site are subject to more frequent flooding. Residential and employment development is proposed east of Otley south of the River Wharfe which lies within Flood Zone 1 so will be at low risk from flooding, however this is a large area which is currently undeveloped and therefore it is important to ensure that measures are taken to reduce the speed of surface water runoff so that the development of this site does not exacerbate flooding elsewhere.

River Wharfe (middle) catchment

Review of Flood Risk

Detailed flood risk modelling of the River Wharfe has been carried out by the Environment Agency, and this has been used to underpin the SFRA in this instance. There is a considerable area of low lying land immediately adjoining the River Wharfe corridor that is susceptible to relatively frequent river flooding. These areas are currently undeveloped, and it is essential that these important floodplain areas are protected against future development.

The majority of the flooding along this section of the River Wharfe is from the predicted 1 in 20 year (Functional Floodplain) and between the 1 in 100 and 1 in 200 year (Flood Zone 2) design events. Currently the following buildings are at risk from the predicted 1-0.1% (1 in 100- 1 in 1000 year) design event (zone 2 medium risk):

1. Industrial buildings near the Cricket Ground at Pool
2. Residential and commercial buildings at Mill Farm, Saw Mill Farm and Bar Lodge just upstream of Harewood Bridge

3. A large area of residential properties in Collingham in and around Linton Road, The Avenue, Kingfisher Reach, Bishopdale Drive and Linton Bridge.

Currently the following buildings are at risk from the predicted 5% (20 year) design event and lie very close to Functional Floodplain;
1. Residential and commercial buildings at Mill Farm in Arthington
2. Residential properties at the lower end of The Avenue in Collingham

Residential properties at the very bottom of The Avenue in Collingham are at risk from rapid inundation should the flood defences at this location along the River Wharfe breech.

Development Pressure

Whiteleys Mill is situated close to the Wharfe at Pool. Only a small proportion of this site is affected by flood risk associated with the predicted 1-0.1% (between the 1 in 100 and 1 in 200 year) design events and it is recommended that in any redevelopment, this part of the site should be used to accommodate open space, car parking or similar open uses. Future development will need to ensure that flood risk is not increased at this site through the use of sustainable drainage techniques, including (for example) infiltration and/or water harvesting, to limit the rate of runoff to the greenfield equivalent. It is also essential that future development does not increase the rate and/or volume of runoff into the local waterways.

River Wharfe (lower) catchment

Review of Flood Risk

The Linton Ings is a large area of Functional Floodplain for the River Wharfe. Here the floodplain is wide and comprises open space such that largely properties and lives are not at risk from flooding in this area. However, the maps indicate that the following are at risk from the predicted 1-0.1% (between the 1 in 100 and 1 in 200 year) design events.

1. Residential properties on Stammergate in Linton
2. An industrial unit on Linton Lane in Linton
3. Residential properties on Linton Road backing on to the Linton Ings
4. Residential properties of Wetherby Grange and near Riverdale
5. Commercial buildings around the Market Place and Westgate, the Police station, sewage pumping station
6. The A661 road to Linton

Development Pressure

Development at Church Fields Boston Spa is adjacent to Flood Zone 2 medium risk. Future development will need to ensure that flood risk is not increased at this site through the use of sustainable drainage techniques, including (for example) infiltration and/or water harvesting, to limit the rate of runoff to the greenfield equivalent. It is also essential that future development does not increase the rate and/or volume of runoff into the local waterways.

River Aire (upper) catchment

Review of Flood Risk

This area (extending from the River Aire/Carr Beck confluence and Gott's Bridge, near Burley) is at risk of flooding from the River Aire from the predicted 5% design event (1 in 20 year). The flood risk extends widely across the floodplain. The majority of this area is open space with development set back from the river corridor. However, Kirkstall Forge, industrial buildings near Bridge road at Kirkstall, Kirkstall Retail Park and industrial buildings near Gott's Bridge are affected by flood risk area associated with the predicted 5% (1 in 20 year) design event. Wyther Drive and Wyther Lane are at risk from the predicted 1% (1 in 100 year) and the 1% - 0.1% (between the 1 in 100 and 1 in 1000 year) design events.

The rugby training centre at Kirkstall and land surrounding it is at risk from rapid inundation following flood defence breeching. There has been flooding historically at Kirkstall Forge of a localised nature.

Some industrial and recreational land near Newlay is at risk of flooding from the River Aire, from the predicted 1% (1 in 100 year) design event.

Development Pressure
There is currently large mixed use development proposed at Kirkstall Forge which currently lies within Flood Zone 3. It is recommended that future development will need to ensure that flood risk is not increased at this site through the use of sustainable drainage techniques, including (for example) infiltration and/or water harvesting, to limit the rate of runoff to the greenfield equivalent. It is also essential that future development does not increase the rate and/or volume of runoff into the local waterways. Parts of the site may need to provide additional space for flood storage.

River Aire (middle) catchment

Review of Flood Risk

The flood risk extends widely across the floodplain from Burley to Stourton which includes Leeds City Centre. The following land is at risk from flooding at different probabilities;

	Flood Zone 2	Zone 3a(i)	Zone 3a(ii)
Land at risk from flooding	Industrial buildings between Canal Mills and Monk Bridge Forge	Industrial buildings at Cardigan Industrial estate	Hotels/car parks and commercial buildings in Leeds City Centre
	Leeds Railway Station	Industrial buildings at Aireside Chemical Works	Commercial buildings of Aireside Centre
	Emmanuel Trading Estate	Industrial buildings at the Brewery	Industrial buildings at Kirkstall Industrial Park extending alongside Kirkstall road
	Car parks on Lisbon Street	Commercial buildings of the office park and retail park off Hunslet Lane	Commercial buildings in Canal Wharf
	Industrial buildings near Camp Field	Industrial buildings of Pottery Field	Commercial buildings in the Business Park off Butterley Street
	Industrial buildings along Crown Point Road	Trading Estate and residential buildings near Low Road	Leisure, industrial and commercial buildings around the Royal Armouries and Clarence Road area
		Retail park on Beza Road, Hunslet	Development sites at Skelton Moor Farm , Hunslet Riverside South and Stourton Riverside
		Residential properties off Arthington Avenue and Norwich Avenue Hunslet	Industrial buildings at Thwaite Gate
			Waterside Industrial Park at Kirkstall Road

There is additionally a small area within zone 3a(ii) which is at risk of rapid inundation at Leeds Bridge in Leeds City Centre and a larger area at Kirkstall close to the new Morrisons supermarket .

Development Pressure

There is a mixed use development proposed at the Kirkstall Road Renaissance site which is at risk of flooding with a 5% (1 in 20 year) annual probability and is affected by zones 3a(ii) and 3a (i).
A mixed use and open space development is proposed at the current Carlsberg Tetley brewery site which is at risk of flooding on average once in every 100 years. Retail development is proposed for Kidacre Street which is not at risk of flooding. Future mixed land use development is proposed at the former Yorkshire Chemicals works which is at risk of flooding with a 5% (1 in 20 year) annual probability. Sustainability of any future development at this site must be carefully considered.

The Aire Valley Area Action Plan falls within this catchment and is the focus for large scale development. Mixed employment uses are proposed at Skelton Moor Farm where parts of the site are in zone 3a(ii). Residential or industrial development has been proposed at Stourton Riverside where the site is also in zone 3a(ii). Sustainability of any future development at this site must be carefully considered. Mixed land use development has been proposed at Hunslet Mills/Yarn Street which is in zone 3a(ii). Sustainability of any future development at this site must be carefully considered.

River Aire (lower) catchment

Review of Flood Risk

Flood risk in the entire River Aire lower catchment extends from the Wyke Beck/River Aire tributary down to Newton Ings. The River Calder joins the River Aire just south of Allerton Bywater and potentially contributes to some flood risk within this area. The flood risk in this area extends widely across the floodplain. The majority of the land at risk of flooding from the predicted 5% (1 in 20 year) design event is open space and old opencast mining land. However, some buildings are at risk of flooding from the predicted 1-0.1% (between the 1 in 100 and 1 in 200 year) design events, and the predicted 1% (1 in 100 year) design event. The following land is at risk from flooding at different probabilities;

	Flood Zone 2	Zone 3a(i)	Zone 3b
Land at risk from flooding	Residential buildings at Juniper Avenue in Woodlesford	Industrial buildings near Juniper Avenue in Woodlesford	Opencast workings
	Residential buildings in Pinder Green	Residential buildings in Pinder Green	The Oxbow Lakes
	Residential buildings on Church Lane, Little Church Lane and Church Side in Methley	Residential buildings on Church Lane. Saville Road, Pinford Lane, Main Street, Oakfield and Summerhill in Mickletown	Newton Ings
	Robinson Street, Back Lane and Victoria Street in Allerton Bywater	Cricket Ground at Allerton Bywater	Ledston Ings
	Dunford House – River Calder		Allerton Ings

There is a large area at risk of rapid inundation should the flood defences breech along Boat Lane and Main Street in Allerton Bywater.

Development Pressure

Development proposed alongside Pontefract Lane is part of the Aire Valley Area Action Plan. Offices, industry and distribution is proposed. A small proportion of the development area lies within a flood risk area associated with Flood Zones 2 and 3a and is adjacent to Functional Floodplain. It is recommended that development here takes a sequential approach to the positioning of different industrial uses within the site and thereby avoids developing the most risky parts.

Bagley Beck and Red Beck Catchment

Review of Flood Risk

Detailed flood risk modelling of Bagley Beck and Red Beck has not been carried out to date, and therefore the SFRA is reliant upon the Environment Agency Flood Zone Map (March 2007). Notwithstanding this however, the predicted 1% (1 in 100 year) design event is contained largely within the waterway corridor, indicating a potential risk only to 'less vulnerable' commercial property situated immediately adjacent to the river. This is reinforced by the absence of any recorded history of river flooding within the catchment

A number of localised flooding issues have been identified in the Bagley Beck catchment in Rodley and Farsley by Leeds City Council, associated largely in this instance with old culverts that are under capacity and in poor condition. A culvert that is under capacity can result in relatively serious surface water flooding, however occurrences of this nature are virtually impossible to predict, and at present the location of these culverts in unknown. To reduce the susceptibility of localised flooding therefore, a risk-based approach must be taken. it is essential that future development does not increase the rate and/or volume of runoff into the local waterways, and that the capacity and condition of these culverts are upgraded. Future redevelopment within the catchment must implement sustainable drainage techniques, including (for example) infiltration and/or water harvesting, to limit the rate of runoff to the Greenfield equivalent.

Development Pressure

There is currently no known development pressure within this area. However it is important that any future redevelopment within these commercial areas considers the potential risk of flooding, avoiding the obstruction of overland flow paths (e.g. through the careful orientation of commercial buildings and associated landscaping).

Oil Mill Beck and Moseley Beck Catchment

Review of Flood Risk

Detailed flood risk modelling of Oil Mill Beck and Moseley Beck has not been carried out to date, and therefore the SFRA is reliant upon the Environment Agency Flood Zone Map (March 2007). Notwithstanding this however, the predicted 1% (100 year) design event is contained largely within the waterway corridor, indicating a potential risk only to 'less vulnerable' commercial property situated immediately adjacent to the river within Horsforth (Low Lane). This is reinforced by the absence of any recorded history of river flooding within the catchment.

A number of localised flooding issues have been identified within the Oil Mill Beck (Moseley Beck) catchment by Leeds City Council, associated largely in this instance with the localised blockage of gullies and culverts. A blocked gully and/or culvert can result in relatively serious surface water flooding, however occurrences of this nature are virtually impossible to predict. To reduce the susceptibility of localised flooding therefore, a risk-based approach must be taken. Regular, proactive maintenance is required to keep local waterway corridors clear of debris. More importantly however, it is essential that future development does not increase the rate and/or volume of runoff into the local waterways.

Development Pressure

There are no specific allocations within this area however there are pressures for changes of use from traditional employment to residential. This has implications for flood risk because it is moving from a less vulnerable to more vulnerable category. A Protected Area of Search for long term housing need is allocated at Cookridge and this could result in increased run off into the water catchment which could lead to increased flood risk. Future redevelopment within the catchment must implement sustainable drainage techniques, including (for

example) infiltration and/or water harvesting, to limit the rate of runoff to the greenfield equivalent.

It is important that any future redevelopment within the commercial areas considers the potential risk of flooding, avoiding the obstruction of overland flow paths (e.g. through the careful orientation of commercial buildings and associated landscaping). There are also implications for any proposed change of use from a less vulnerable to a more vulnerable category eg. from employment use to residential.

Meanwood Beck, Adel Beck and Sheepscar Beck catchment

Review of Flood Risk

Detailed flood risk modelling of Adel Beck, Meanwood Beck and Sheepscar Beck has not been carried out to date, and therefore the SFRA is reliant upon the Environment Agency Flood Zone Map (March 2007). Notwithstanding this however, the predicted 1% (1 in 100 year) design event is contained largely within the waterway corridor of Adel Beck, indicating a potential risk to residential property at Adel Mill which is situated adjacent to the watercourse. The predicted 1% (1 in 100 year) design event is contained largely within the waterway corridor of Meanwood Beck, indicating a potential risk to residential property at Valley Farm at Weetwood, and Boothroyd Drive at Meanwood which is situated adjacent to the watercourse. The predicted 1% (1 in 100 year) design event is contained largely within the waterway corridor of Sheepscar Beck, indicating a potential risk to industrial property at Buslingthorpe, and commercial and industrial property between Buslingthopre and Quarry Hill which is situated adjacent to the watercourse.

A number of localised flooding issues have been identified within the Meanwood Beck catchment by Leeds City Council, associated largely in this instance with ability of floodwaters to flow under an existing road bridge (Monk Bridge, Far Headingley). The backing up of floodwaters behind Monk Bridge in Far Headingley results in a greater depth of flooding. The lateral extent of floodwaters has been known to be greater than those indicated by the Environment Agency's flood maps. A number of localised flooding issues have been identified within the Meanwood Beck catchment by Leeds City Council, largely due to the blockage of the channel by fly tipping which obstructs flood flows (Buslingthorpe Lane, Meanwood).

Development Pressure

To reduce the susceptibility of localised flooding in the catchment, a risk-based approach must be taken. The capacity of the channel where the road bridge crosses it needs to be addressed. Regular, proactive maintenance is required to keep local waterway corridors clear of debris. More importantly however, it is essential that future development does not increase the rate and/or volume of runoff into the local waterways. Future redevelopment within the catchment must implement sustainable drainage techniques, including (for example) infiltration and/or water harvesting, to limit the rate of runoff to the greenfield equivalent.

Wyke Beck catchment

Review of Flood Risk

Detailed flood risk modelling of Wyke Beck has been carried out by the Environment Agency. The 1 – 0.1% (1 in 100 - 1 in 1000 year) design event is contained largely within the waterway corridor of Wyke Beck but occasionally spreads out in isolated locations, indicating a potential risk to schools, a leisure centre and residential properties in Halton Moor; residential properties downstream of Killingbeck Bridge to Halton Moor, Wyke Beck Valley Road, and Grange Park Road at Hollins Park; and industrial properties at Pembroke Grange.

A number of localised flooding issues have been identified within the Wyke Beck catchment by Leeds City Council mostly associated with blockages due to inadequate culvert size at Wyke Bridge during times of high flow causing flooding of a group of properties on Dunhill Rise. The capacity of this culvert needs to be addressed to avoid future flooding potential.

The area of East Leeds has been identified by Leeds City Council as a major area for concern with regard to the capacity of the public sewer system. Localised flooding outside the main floodplain has been associated with an under capacity combined trunk sewer system (as detailed in the Joint Report produced by Leeds City Council and Yorkshire Water). Future development within the East Leeds area could contribute more water to the existing sewer system putting more properties at higher flood risk. Redevelopment in Seacroft could exacerbate flooding problems on Wyke Beck upstream of York Road. Sewered catchments in the Parkway and Seacroft areas have experienced localised flooding problems. A Strategic approach must be taken to future development in this area which involves providing appropriate mitigation measures against increasing flood risk.

Development Pressure

There is considerable development proposed within the Wyke Beck catchment. Proposed development at Seacroft Hospital, Coldcotes Circus and Asket Drive/Boggarts are not at any flood risk. Proposed development sites at Brander Road, Whitebridge Primary School and a small part of South Parkway/Brooklands are at risk of flooding with a 0.1% (1 in 1000 year) annual probability since the sites lie within Flood Zone 2. These sites are appropriate for more vulnerable, less vulnerable or water compatible uses. Highly vulnerable land uses are only permissible in these locations if the Exception test has been passed and development provides wider sustainability benefits to the community that outweigh flood risk. Sites at Skelton Moor Farm and Hunslet Riverside South are in the highest flood risk zone 3a(ii) and have a 5% (1 in 20 year) annual flood risk probability. Only water compatible, essential infrastructure and less vulnerable uses are appropriate here and redevelopment should take the opportunity to reduce flood risk by providing areas of flood storage within the site. Cartmell Drive is not itself in a flood risk zone however it is located close to functional floodplain on the Wyke Beck, therefore any development of that site needs to take measures to ensure that it does not increase the speed of surface water runoff to Wyke Beck.

To reduce the susceptibility of localised flooding therefore, a risk-based approach must be taken. The capacity of the channel where the road bridge crosses it needs to be addressed. Regular, proactive maintenance is required to keep local waterway corridors clear of debris. More importantly however, it is essential that future development does not increase the rate and/or volume of runoff into the local waterways. Future redevelopment within the catchment must implement sustainable drainage techniques, including (for example) infiltration and/or water harvesting, to limit the rate of runoff to the greenfield equivalent.

Tyresal Beck, Pudsey Beck, Farnley Beck and Wortley Beck catchments

Review of Flood Risk

Detailed flood risk modelling of Tyresal Beck, Pudsey Beck, Farnley Beck and Wortley Beck has not been carried out to date, and therefore the SFRA is reliant upon the Environment Agency Flood Zone Map (March 2007). Notwithstanding this however, the predicted 1% (1 in 100 year) design event is contained largely within the waterway corridor of Tyresal Beck, Pudsey Beck, Farnley Beck and Wortley Beck. Potential flood risk is indicated to industrial property at Troydale Lane which is situated adjacent to the Pudsey Beck; residential property at risk at Hare Park Avenue from Farnley Beck; industrial buildings are at risk near Bangor Terrace which is situated adjacent to Wortley Beck; and industrial, commercial and residential properties are at risk in the Beeston Bridge and One City West Office Park areas which are situated adjacent to Wortley Beck.

A number of localised flooding issues have been identified within the Wortley Beck catchment by Leeds City Council, associated largely in this instance with the localised blockage of gullies and culverts. A blocked gully and/or culvert can result in relatively serious surface water flooding, however occurrences of this nature are virtually impossible to predict.

Development Pressure

To reduce the susceptibility of localised flooding in the catchment, a risk-based approach must be taken. Regular, proactive maintenance is required to keep local waterway corridors clear of debris. More importantly however, it is essential that future development does not increase the rate and/or volume of runoff into the local waterways. Future redevelopment within the catchment must implement sustainable drainage techniques, including (for example) infiltration and/or water harvesting, to limit the rate of runoff to the greenfield equivalent.

Mill Shaw Beck and Farnley Wood Beck catchment (encompassing Cotton Mill Beck and Woodcliffe Beck)

Review of Flood Risk

Detailed flood risk modelling of Mill Shaw Beck and Farnley Wood Beck has not been carried out to date, and therefore the SFRA is reliant upon the Environment Agency Flood Zone Map (March 2007). The predicted 1% (1 in 100 year) design event is contained largely within the waterway corridor of Farnley Wood Beck, but is generally more widespread along the corridor of Mill Shaw Beck downstream of the confluence with Farnley Wood Beck.

Potential flood risk is indicated to industrial property at Millshaw Park Avenue/Lane which is situated adjacent to the confluence of Mill Shaw Beck and Farnley Wood Beck; industrial and commercial buildings are at risk along Beeston Ring Road from Manor Mill to Elland Road Industrial Park adjacent to Mill Shaw Beck; Latchmore Road industrial estate and part of Elland Road stadium is at risk of flooding from the 1% (1 in 100 year) design event from Mill Shaw Beck just downstream of where Wortley Beck converges with Mill Shaw Beck. Industrial and commercial properties are at risk of flooding from the 1% (1 in 100 year) design event from Mill Shaw Beck between Brown Avenue and Bath Street. Commercial properties are at risk of flooding from the 5% (1 in 20 year) design event from Mill Shaw Beck alongside Water Lane and Canal Wharf where Mill Shaw Beck joins the River Aire. Industrial property and an electricity generating station (essential infrastructure) are at risk of flooding from the predicted 1% (1 in 100 year) design event from Cotton Mill Beck. Leeds City Council has stated that these localised flooding problems result from the culvert along Cotton Mill Beck having insufficient capacity, and collapses of the culvert have occurred in the past. The culvert along Cotton Mill Beck will be replaced by Leeds City Council in order to minimise localised flooding problems in this area.

A number of localised flooding issues have been identified with Farnley Wood Beck by Leeds City Council, and are the subject of a study currently being undertaken by the Environment Agency. Known problem areas include upstream of culverts in the Elland Road and Old Road areas where residential properties are affected, due to a lack of capacity of these culverts. Industrial and commercial buildings are affected by localised flooding problems at the confluence of Farnley Wood Beck and Mill Shaw Beck.

Development Pressure

To reduce the susceptibility of localised flooding in the catchment, a risk-based approach must be taken. Regular, proactive maintenance is required to keep local waterway corridors clear of debris. More importantly however, it is essential that future development does not increase the rate and/or volume of runoff into the local waterways. Future redevelopment within the catchment must implement sustainable drainage techniques, including (for example) infiltration and/or water harvesting, to limit the rate of runoff to the greenfield equivalent.

Oulton Beck catchment (encompassing Lee Moor Beck, Bowling Beck and West Beck)

Review of Flood Risk

Detailed flood risk modelling of Oulton Beck has not been carried out to date, and therefore the SFRA is reliant upon the Environment Agency Flood Zone Map (March 2007). The

predicted 1% (1 in 100 year) design event is contained largely within the waterway corridor of Oulton Beck, but becomes generally more widespread at the downstream end of the Beck at the confluence of the River Aire. Potential flood risk is indicated to residential properties at Gillett Bridge in Oulton, and to residential properties near Farrer Lane, the A642 and A639 in Oulton. Downstream of Oulton village the flood risk extends further across the land adjacent to Oulton Beck but the land is mostly open space and little property is at flood risk. However, a small proportion of the sewage works near Water Haigh Farm is at risk of flooding from the predicted 1-0.1% (1 in 100- 1 in 1000 year) design event.

A small proportion of an industrial building is at risk from the predicted 1% (1 in 100 year) design event from West Beck near New Close Well, West Beck. Residential property is at risk from the predicted 1% (1 in 100 year) design event at Stainton Lane, near Stone Bridge in Carlton from Lee Moor Beck.

Development Pressure

Major development has been proposed in the Middleton area within falls within the Oulton Beck catchment. Development needs to incorporate balancing ponds to ensure that flood risk is not exacerbated downstream. Localised flooding problems are known to exist in the Springhead Park area of Rothwell and low lying areas upstream of it.

Cock Beck catchment

Review of Flood Risk

Detailed flood risk modelling of Cock Beck has not been carried out to date, and therefore the SFRA is reliant upon the Environment Agency Flood Zone Map (March 2007). The predicted 1% (1 in 100 year) design event is contained largely within the waterway corridor of Cock Beck, but becomes generally more widespread downstream of the confluence with Potterton Beck to Aberford. Residential properties are at risk of flooding from the predicted 1% (1 in 100 year) design event around Aberford Bridge in Aberford, and Stanks Drive in Swarcliffe. Although properties near Stanks Bridge in Stanks are very close to flood zones 2 and 3a, it would appear that properties are not actually at flood risk from Cock Beck. However localised flooding problems have been recorded in the Stanks Bridge area with roads and properties being affected in the past.

A number of localised flooding issues have been identified within the Cock Beck catchment by Leeds City Council, associated largely in this instance with the localised blockage of trash screens and under capacity surface water sewers. A blocked watercourse and under capacity sewers can result in relatively serious surface water flooding, however occurrences of this nature are virtually impossible to predict. To reduce the susceptibility of localised flooding therefore, a risk-based approach must be taken. Regular, proactive maintenance is required to keep local waterway corridors clear of debris.

Development Pressure

Major development is proposed in this area under the East of Leeds Extension immediately to the west of Cock Beck. It is essential that future development does not increase the rate and/or volume of runoff into the local waterways. The Cock Beck corridor flows through this site and should be protected by a minimum 8m buffer zone. Future redevelopment within the catchment must also implement sustainable drainage techniques, including (for example) infiltration and/or water harvesting, to limit the rate of runoff to the Greenfield equivalent, and upgrade any water infrastructure according to the proposed development.

Kippax Beck 9 (encompassing Sheffield Beck and Lin Dike)

Review of Flood Risk

Detailed flood risk modelling of Kippax Beck has not been carried out to date, and therefore the SFRA is reliant upon the Environment Agency Flood Zone Map (March 2007). The

predicted 1% (1 in 100 year) design event is contained largely within the waterway corridor of The Beck, Kippax Beck and Sheffield Beck, but becomes generally more widespread downstream of Great Preston to the confluence of the River Aire where Kippax Beck flows into Sheffield Beck and Lin Dike.

Residential properties are at risk of flooding from the predicted 1% (1 in 100 year) design event from Kippax Beck just west of Glencoe Gardens at Great Preston. A wide section of land adjacent to Lin Dike downstream of Ledston Mill Lane to the confluence with the River Aire is within the Functional Floodplain (1 in 20 year flood) forming some of the Newton Ings area; however this land is open space and roads such that no properties or buildings are at risk from flooding.

A number of localised flooding issues have been identified within the Garforth and Kippax catchments by Leeds City Council, associated, in the case of Garforth, with the capacity of culverted watercourses. These are in poor condition and have not been maintained to a modern standard such that floodwater backs up causing flooding.

In Kippax there are suspected sewer capacity problems in the Valley Road area.

Development Pressure

There are no known development pressures currently within this catchment. However since there are known flooding problems any new development should assess whether the capacity of current sewers are sufficient to cope with surface runoff without increasing flood risk. Future redevelopment within the catchment must implement sustainable drainage techniques, including (for example) infiltration and/or water harvesting, to limit the rate of runoff to the greenfield equivalent.

Eccup Beck (encompassing Stank Beck)

Review of Flood Risk

Detailed flood risk modelling of Eccup Beck has not been carried out to date, and therefore the SFRA is reliant upon the Environment Agency Flood Zone Map (March 2007). The predicted 1% (1 in 100 year) design event is contained largely within the waterway corridor of Eccup Beck and Stank Beck. Land immediately adjacent to Eccup Beck to generally open space therefore no properties or lives are at risk from flooding. One property is at risk of flooding from the predicted 1% (1 in 100 year) design event at Stank.

Hawks House near the Otley Road is at risk from flooding from Stank Beck from the predicted 1% (100 year) design event. Mill Farm and Saw Mill immediately next to the River Wharfe are at risk from flooding from Stank Beck from the predicted 1% - 0.1% (between the 1 in 100 and 1 in 1000 year) design event. Flooding from the River Wharfe may contribute some of this risk of flooding at Mill Farm and Saw Mill.

Development Pressure

There are no known development pressures currently within this catchment, however to reduce the susceptibility of localised flooding, a risk-based approach must be taken. Regular, proactive maintenance is required to keep local waterway corridors clear of debris. More importantly however, it is essential that future development does not increase the rate and/or volume of runoff into the local waterways. Future redevelopment within the catchment must implement sustainable drainage techniques, including (for example) infiltration and/or water harvesting, to limit the rate of runoff to the greenfield equivalent.

Keswick Beck, Collingham Beck and Bardsey Beck catchment

Review of Flood Risk

Detailed flood risk modelling of Keswick Beck, Collingham Beck and Bardsey Beck has not been carried out to date, and therefore the SFRA is reliant upon the Environment Agency Flood Zone Map (March 2007). The predicted 1% (1 in 100 year) design event is contained largely within the waterway corridor of Keswick Beck, Collingham Beck and Bardsey Beck. However, some residential properties are at risk from Keswick Beck from the predicted 1% (100 year) design event at Millbeck Green and The Vale at Collingham. Some residential properties are at risk from Collingham Beck from the predicted 1% (1 in 100 year) design event at Meadow Close and Paddock View at Rigton Hill. Some residential properties are at risk from the predicted 1% - 0.1% (between the 1 in 100 and 1 in 1000 year) design event at the confluence of Bardsey Beck and Gill Beck; at Keswick Lane in Bardsey from Bardsey Beck; and at Cornmill Lane, Bardsey from Bardsey Beck.

Development Pressure

Settlements in this area are constrained by Green Belt boundaries. Development pressure tends to be limited to infilling within the villages. Future redevelopment within the catchment must implement sustainable drainage techniques, including (for example) infiltration and/or water harvesting, to limit the rate of runoff to the greenfield equivalent.

Nun Royd Beck, Henshaw Beck and Guiseley Beck catchment

Review of Flood Risk

Detailed flood risk modelling of Nun Royd Beck, Henshaw Beck and Guiseley Beck catchment has not been carried out to date, and therefore the SFRA is reliant upon the Environment Agency Flood Zone Map (March 2007). The predicted 1% (1 in 100 year) design event is contained largely within the waterway corridor of Nun Royd Beck, Henshaw Beck and Guiseley Beck. However, some commercial properties are at risk from Nun Royd Beck from the predicted 1% (1 in 100 year) design event at the Business Park and Builders Yard in New Scarborough situated between Guiseley and Yeadon. Leeds City Council has identified several localised flooding problems in Guiseley associated with a lack of capacity and poor condition of culverts. These culverts require regular maintenance and clearing in order to reduce flood risk.

Development Pressure

Guiseley and Yeadon are popular places to live and with the benefit of a railway station at Guiseley. There is a demand for more housing in these areas, however there are no major allocations proposed in the immediate future. Most development pressure results from the redevelopment of redundant traditional employment uses to residential development. Future redevelopment within the catchment must implement sustainable drainage techniques, including (for example) infiltration and/or water harvesting, to limit the rate of runoff to the greenfield equivalent.

Scarcroft, Thorner and Bramham

Review of Flood Risk

Detailed flood risk modelling of Mill Beck, Milner Beck, Thorner Beck, Scarcroft Beck and Bramham Beck catchment has not been carried out to date, and therefore the SFRA is reliant upon the Environment Agency Flood Zone Map (March 2007). The predicted 1% (1 in 100 year) design event is contained largely within the waterway corridor of Mill Beck, Milner Beck, Thorner Beck, Scarcroft Beck and Bramham Beck. However some residential properties are at risk from the predicted 1% (1 in 100 year) design event at Sedgegarth, Thorner from Mill Beck and at Firbeck and New Road, Bramham from Bramham Beck. Some residential

properties are at risk from the predicted 1% - 0.1% (between the 1 in 100 and 1 in 1000 year) design event at Clifford Road, Bramham from Bramham Beck.

Development Pressure

These are popular villages where house prices tend to be higher than average. Villages are constrained by the Green Belt boundary and there is little capacity for new development. Future redevelopment within the catchment must implement sustainable drainage techniques, including (for example) infiltration and/or water harvesting, to limit the rate of runoff to the greenfield equivalent.

Appendix B
Areas at Risk of Sewer Flooding
Source: Yorkshire Water (2007)

Recorded Affected Properties and Areas

Internal Flooding	No. of Properties currently affected by sewer flooding	External Flooding	No. of Properties currently affected by sewer flooding
1 in 10 Year	1 in Woodlesford 1 in Drighlington 1 in Methley 1 in Middleton 1 in Meanwood 1 in Horsforth	1 in 10 Year	3 in Rothwell 3 in Cookridge 2 in Colton 2 in Gildersome 2 in Meanwood 2 in Middleton 1 in Halton Moor 1 in Drighlington 1 in Kirkstall 1 in Bardsey 1 in Methley 1 in Rodley 1 in Wortley 1 in New Farnley
1 in 20 Year	12 in Gipton 2 in Middleton 1 in Harehills	1 in 20 Year	2 in Horsforth 1 in Morley 1 in Bardsey 1 in West Park 1 in Methley 1 in Stanningley 1 in Gildersome 1 in Gipton
1 in 30 Year	4 in Chapeltown 1 in Meanwood	1 in 30 Year	2 in Alwoodley 1 in Methley
2 in 10 Year		2 in 10 Year	2 in Gildersome 1 in Alwoodley 1 in Tingley 1 in Drighlington 1 in Wortley 1 in Wetherby 1 in Tinshill
1 in 30 Year	9 in Roundhay 6 in Colton 5 in Headingley 4 in Crossgates 2 in Harehills 2 in Pudsey 2 in Beeston 1 in Allerton Bywater 1 in Kirkstall 1 in Morley 1 in Collingham 1 in Churwell 1 in Oakwood 1 in Seacroft 1 in Gildersome	1 in 30 Year	1 in Weetwood 1 in Gipton 1 in Gildersome 1 in Alwoodley

Rapid Inundation Area
Zone 3b Functional Floodplain
Zone 3a(ii) High Probability
Zone 3a(i) High Probability
Zone 2 Medium Probability
LCC Boundary

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Character Area Overview

Rapid Inundation Area
Zone 3b Functional Floodplain
Zone 3a(ii) High Probability
Zone 3a(i) High Probability
Zone 2 Medium Probability
LCC Boundary

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34
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38
39

Index to Area Maps

Zone 3 High Probability

Leeds City Council Boundary

Watercourses

Local Flood Incidents

Local Flood Incident Overview

Please note that in some locations (particularly within rural upper reaches) uncertainty in the delineation of the waterway centreline and/or 'High Probability' flood zone is anticipated. Further detailed site based analyses are essential to interrogate more fully the risks posed to potential future developments within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the PPS25 flood zones.

River Wharfe

Eccup Beck

Collingham

Fir Green Beck

Cock Beck

Oil Mill

River Aire

Meanwood Beck

Bagley Beck

Wyke Beck

Millshaw Beck

Lin Dyke

Oulton Beck

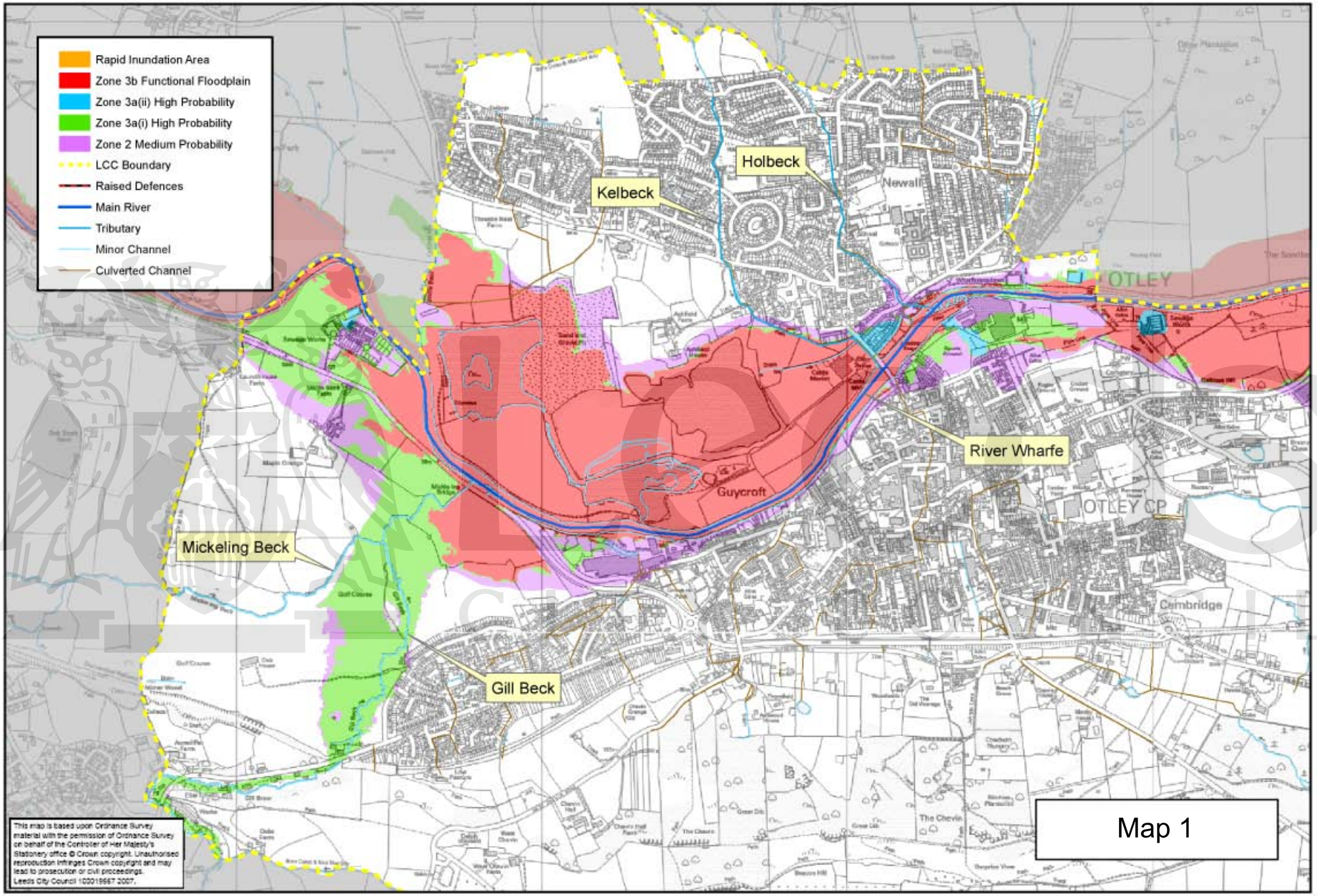
Leeds City Council Boundary

Watercourse Catchment

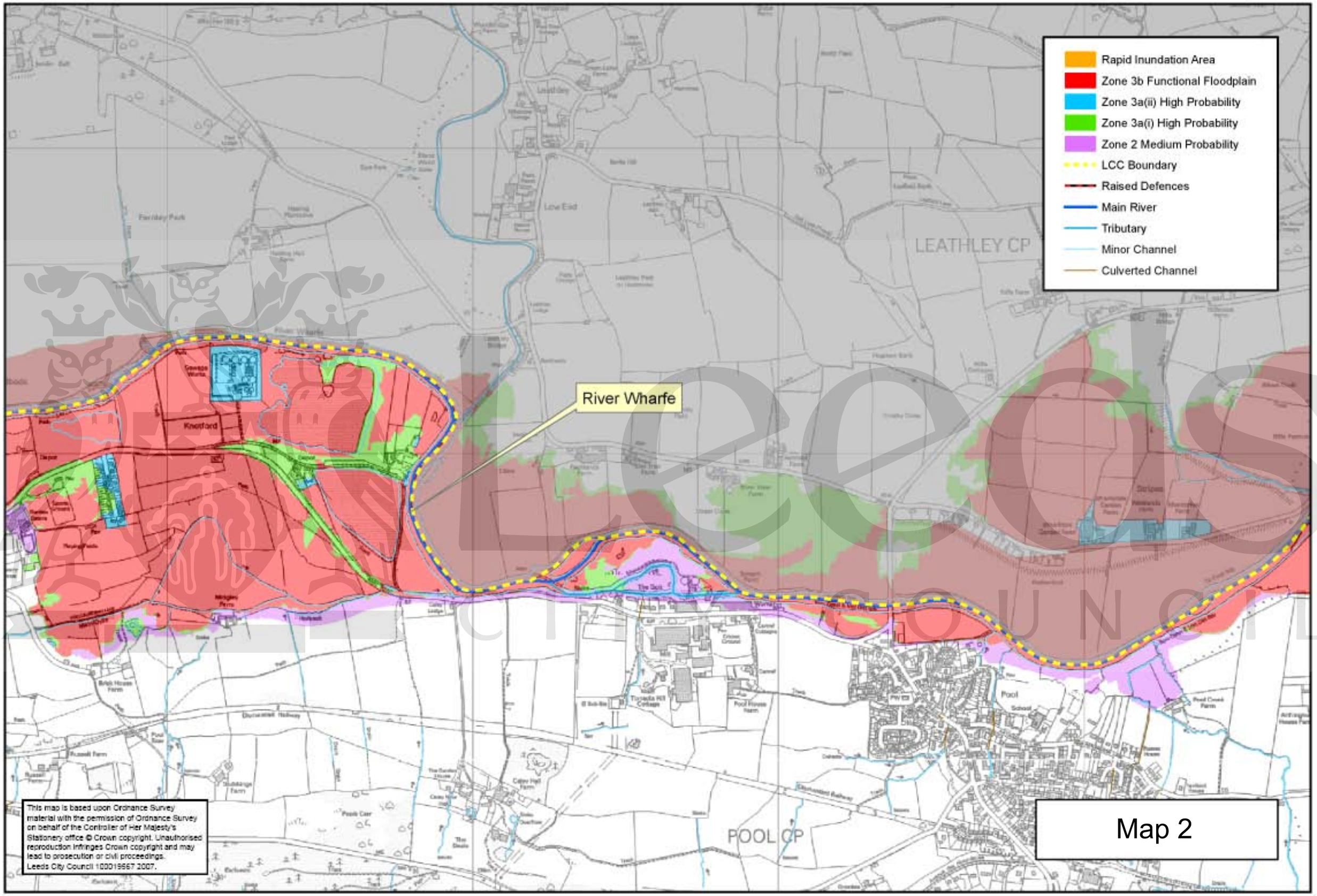
Zone 3 High Probability

Brook Catchment Overview

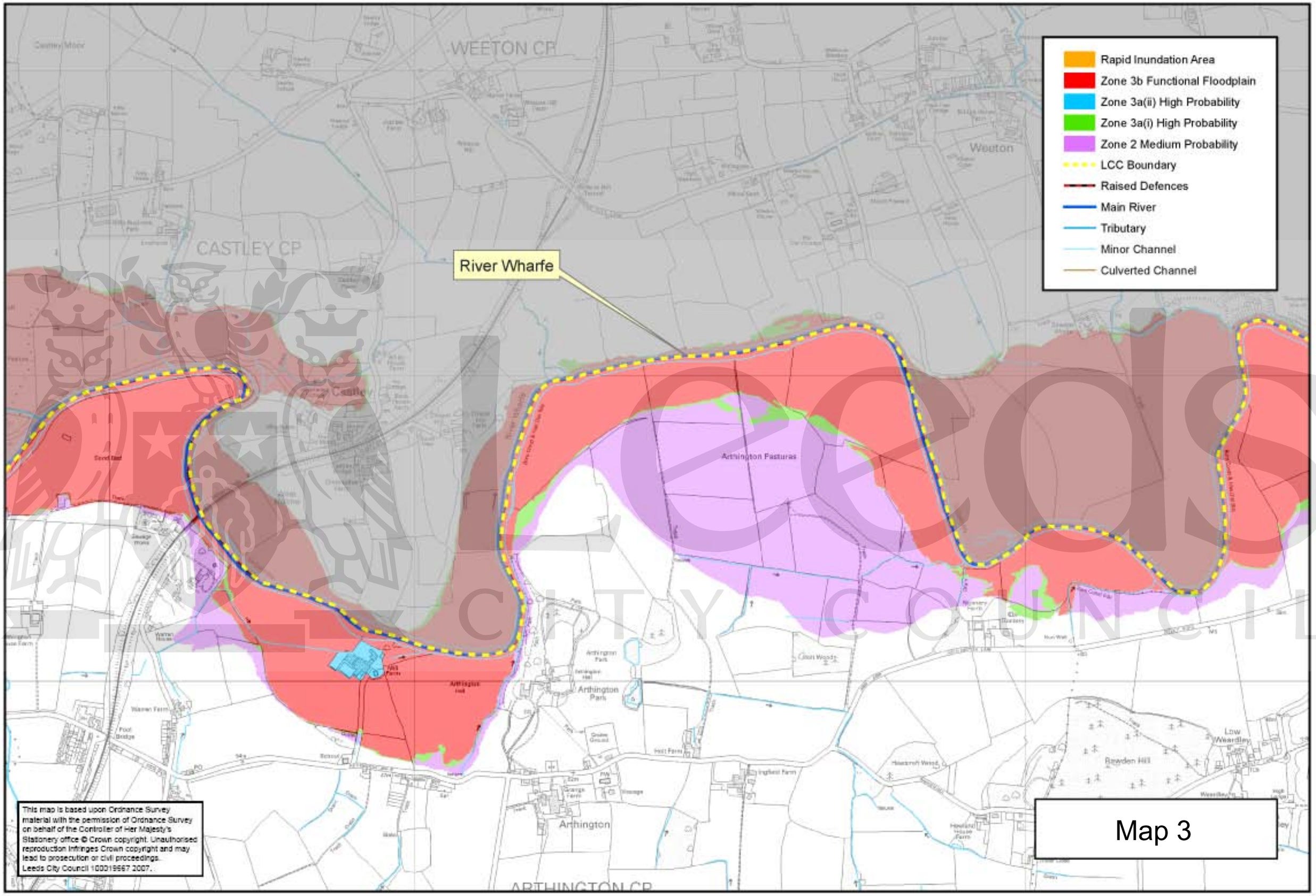
Please note that in some locations (particularly within rural upper reaches) uncertainty in the delineation of the waterway centreline and/or 'High Probability' flood zone is anticipated. Further detailed site based analyses are essential to interrogate more fully the risks posed to potential future developments within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the PPS25 flood zones.



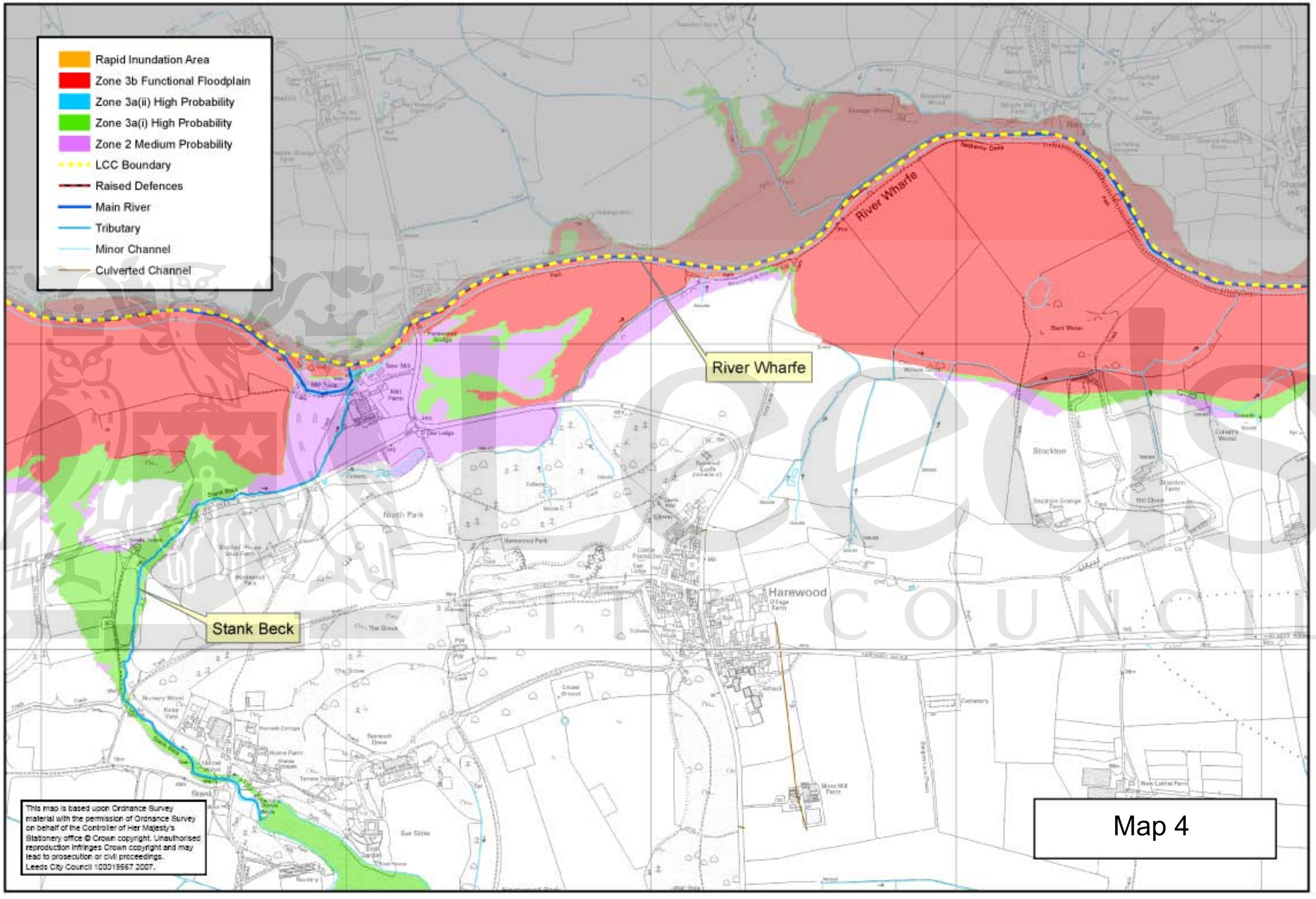
Please note that in some locations (particularly within rural upper reaches) uncertainty in the delineation of the waterway centreline and/or 'High Probability' flood zone is anticipated. Further detailed site based analyses are essential to interrogate more fully the risks posed to potential future developments within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the PPS25 flood zones.



Please note that in some locations (particularly within rural upper reaches) uncertainty in the delineation of the waterway centreline and/or 'High Probability' flood zone is anticipated. Further detailed site based analyses are essential to interrogate more fully the risks posed to potential future developments within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the PPS25 flood zones.



Please note that in some locations (particularly within rural upper reaches) uncertainty in the delineation of the waterway centreline and/or 'High Probability' flood zone is anticipated. Further detailed site based analyses are essential to interrogate more fully the risks posed to potential future developments within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the PPS25 flood zones.



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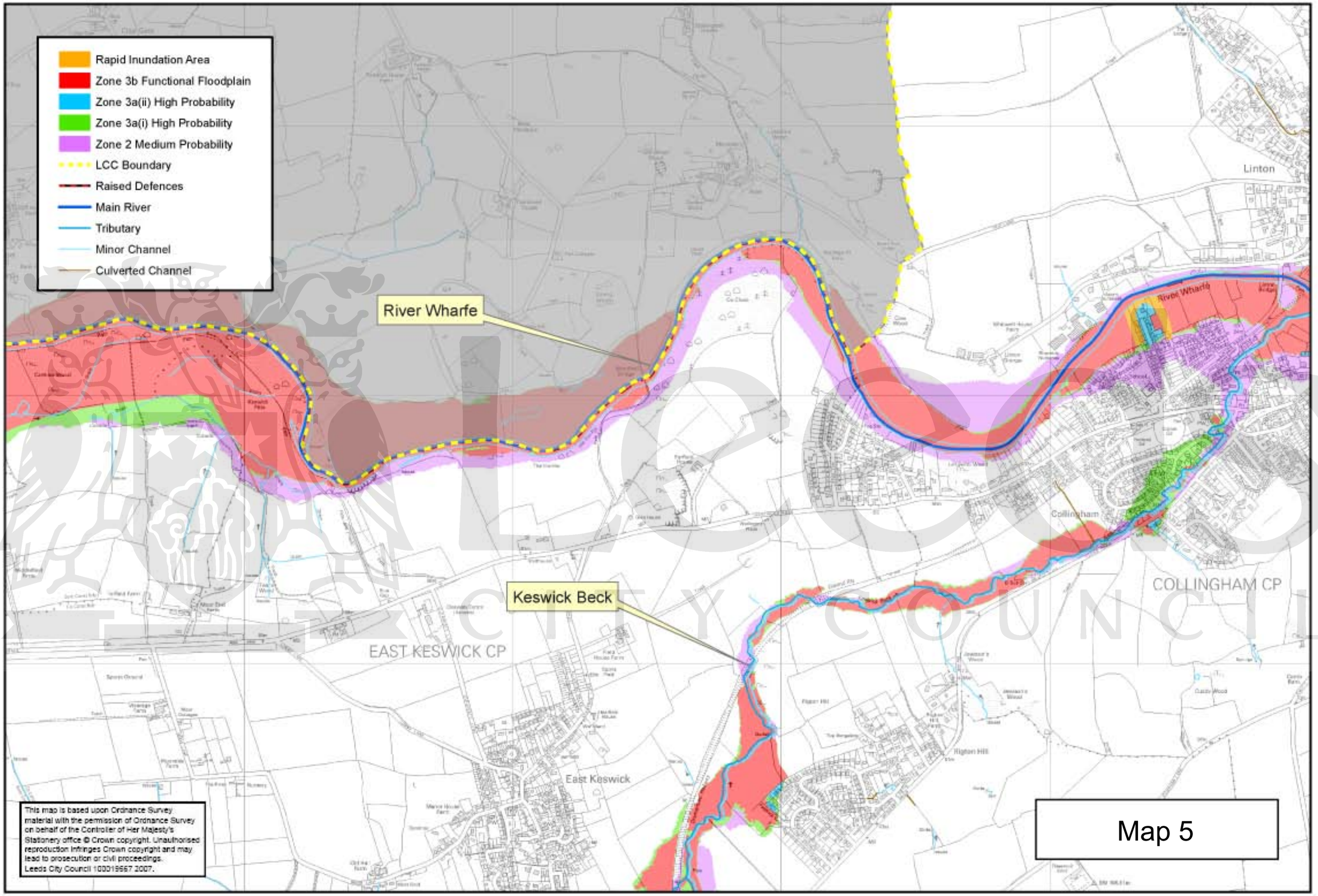

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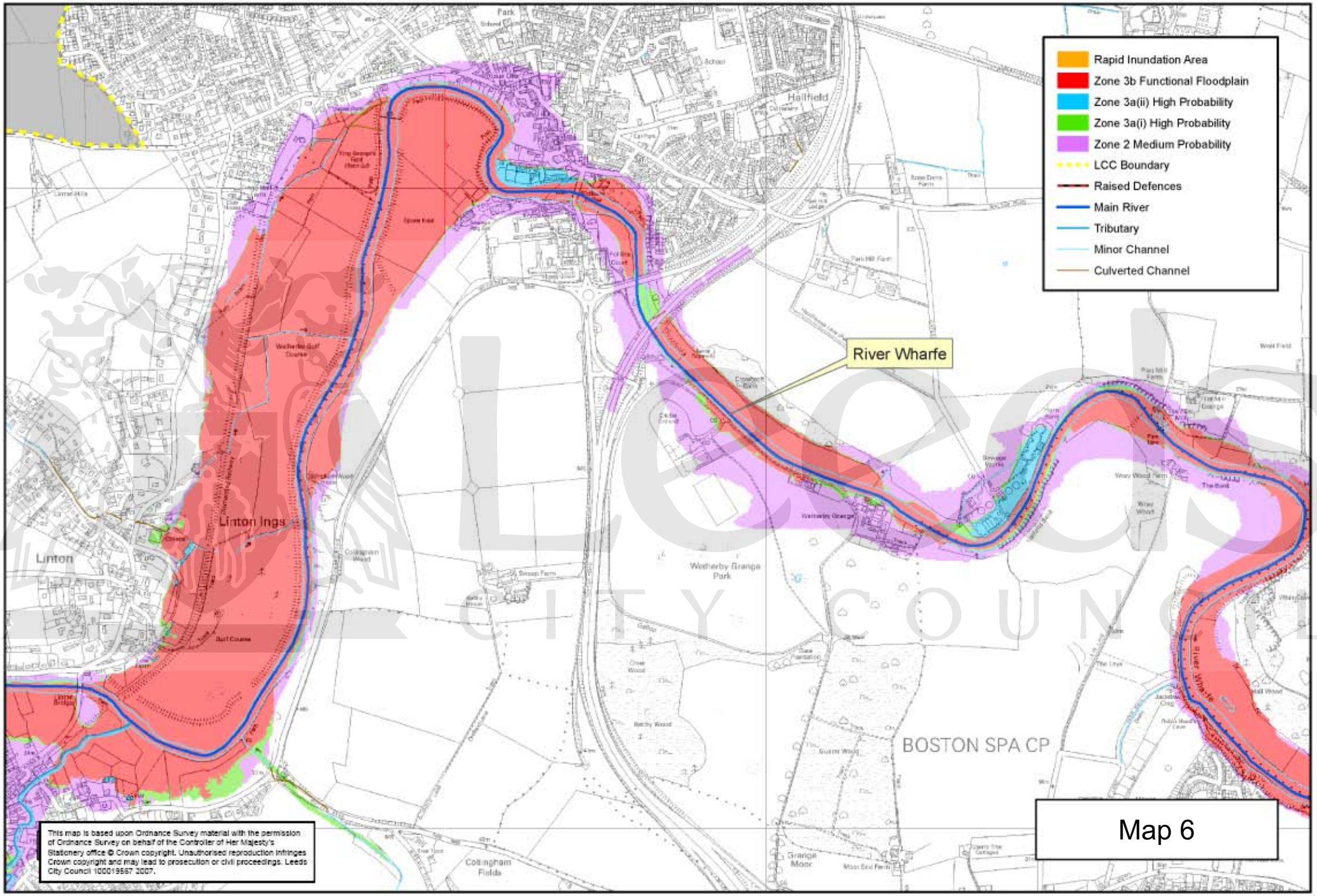

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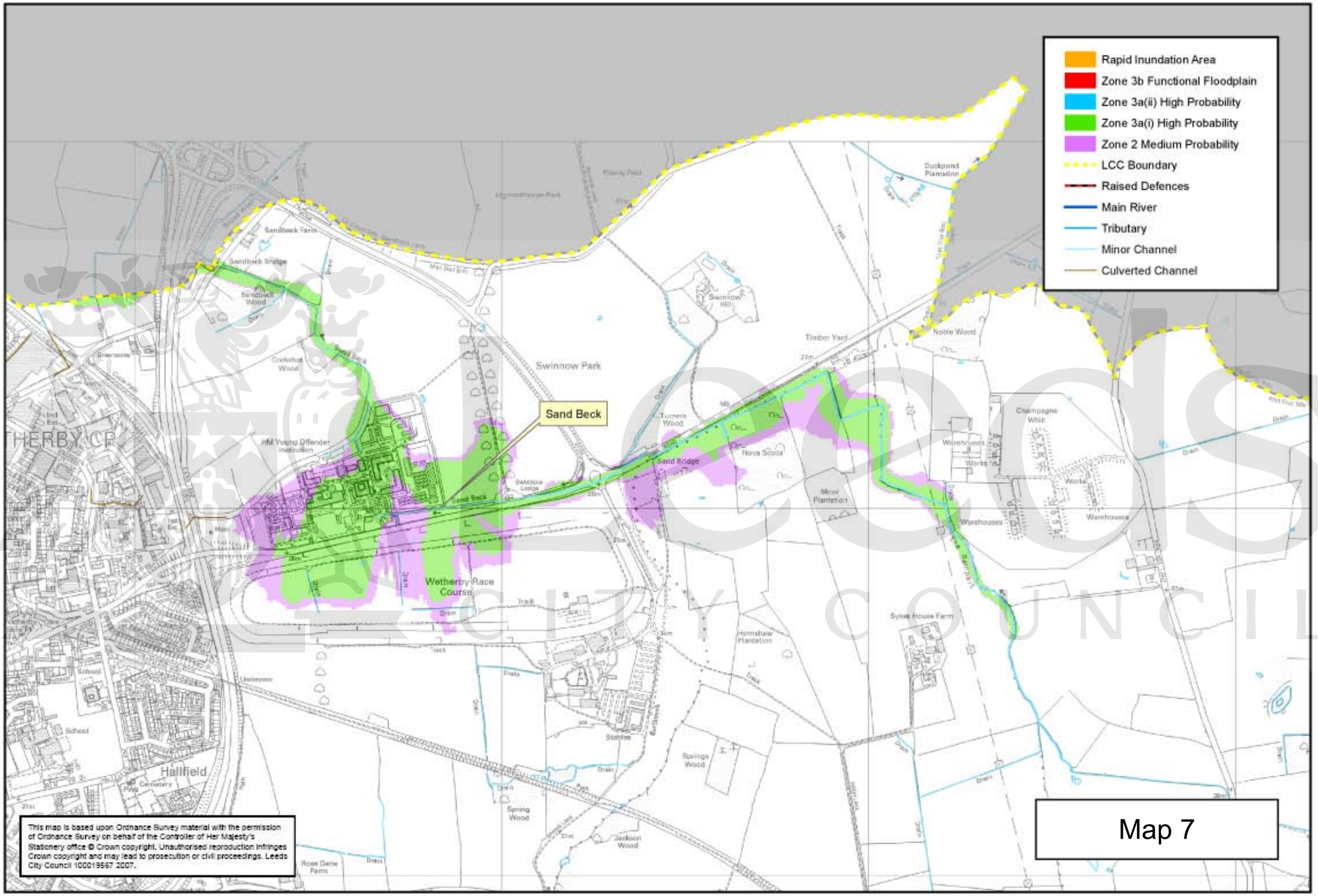
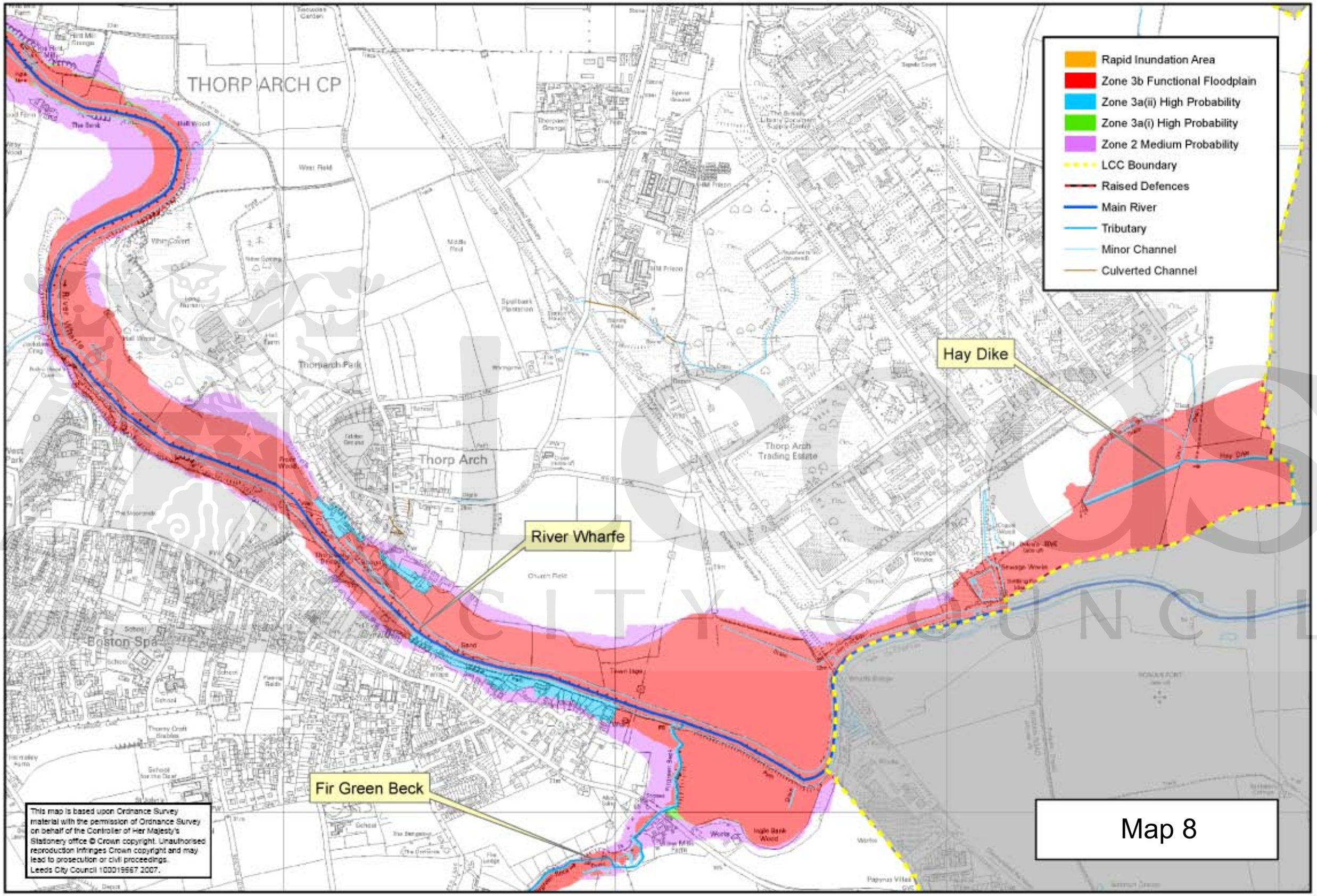


Please note that in some locations (particularly within rural upper reaches) uncertainty in the delineation of the waterway centreline and/or 'High Probability' flood zone is anticipated. Further detailed site based analyses are essential to interrogate more fully the risks posed to potential future developments within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the PPS25 flood zones.



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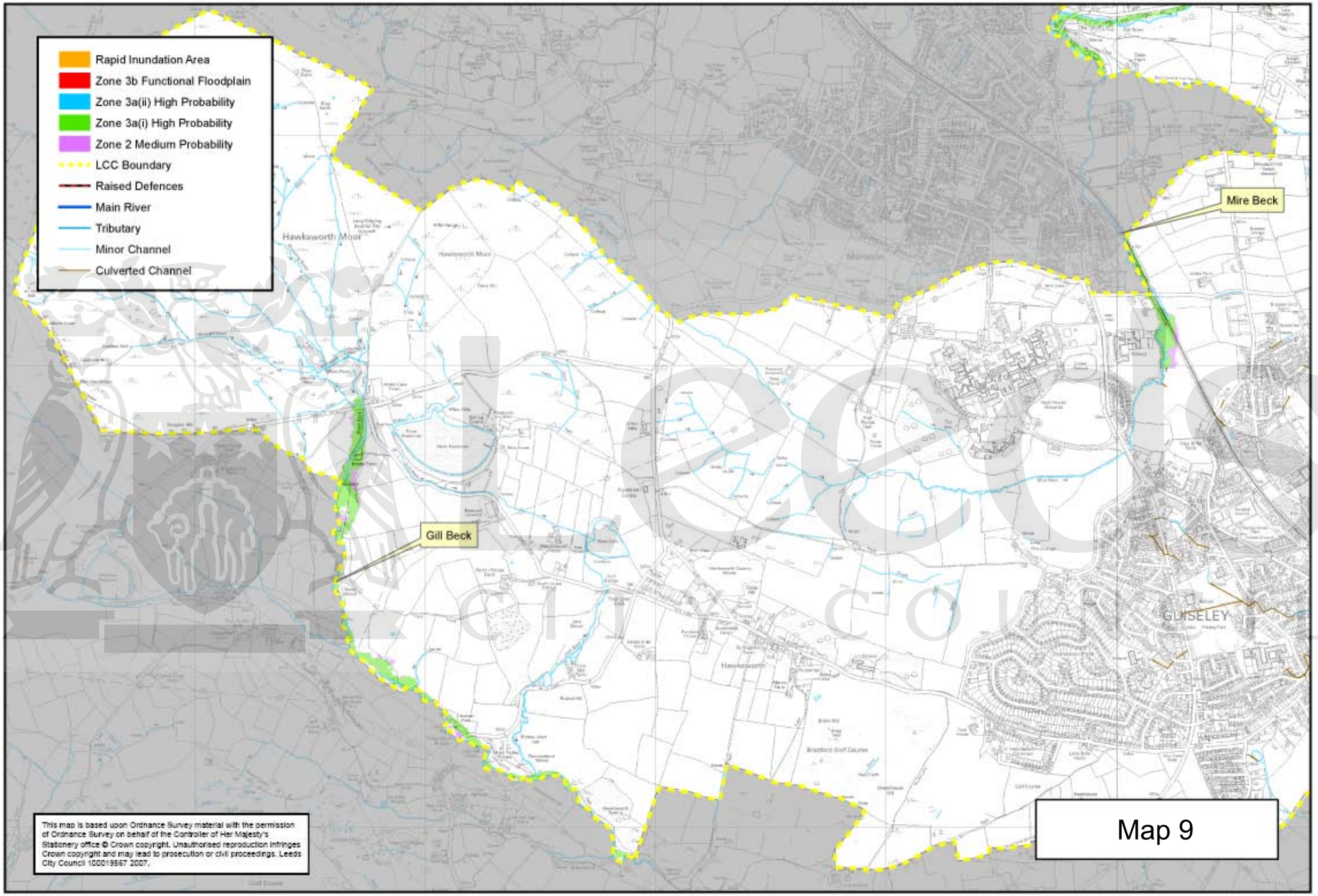


Please note that in some locations (particularly within rural upper reaches) uncertainty in the delineation of the waterway centreline and/or 'High Probability' flood zone is anticipated. Further detailed site based analyses are essential to interrogate more fully the risks posed to potential future developments within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the FP525 flood zones.

Rapid Inundation Area
Zone 3b Functional Floodplain
Zone 3a(ii) High Probability
Zone 3a(i) High Probability
Zone 2 Medium Probability
LCC Boundary
Raised Defences
Main River
Tributary
Minor Channel
Culverted Channel

Guisley Beck

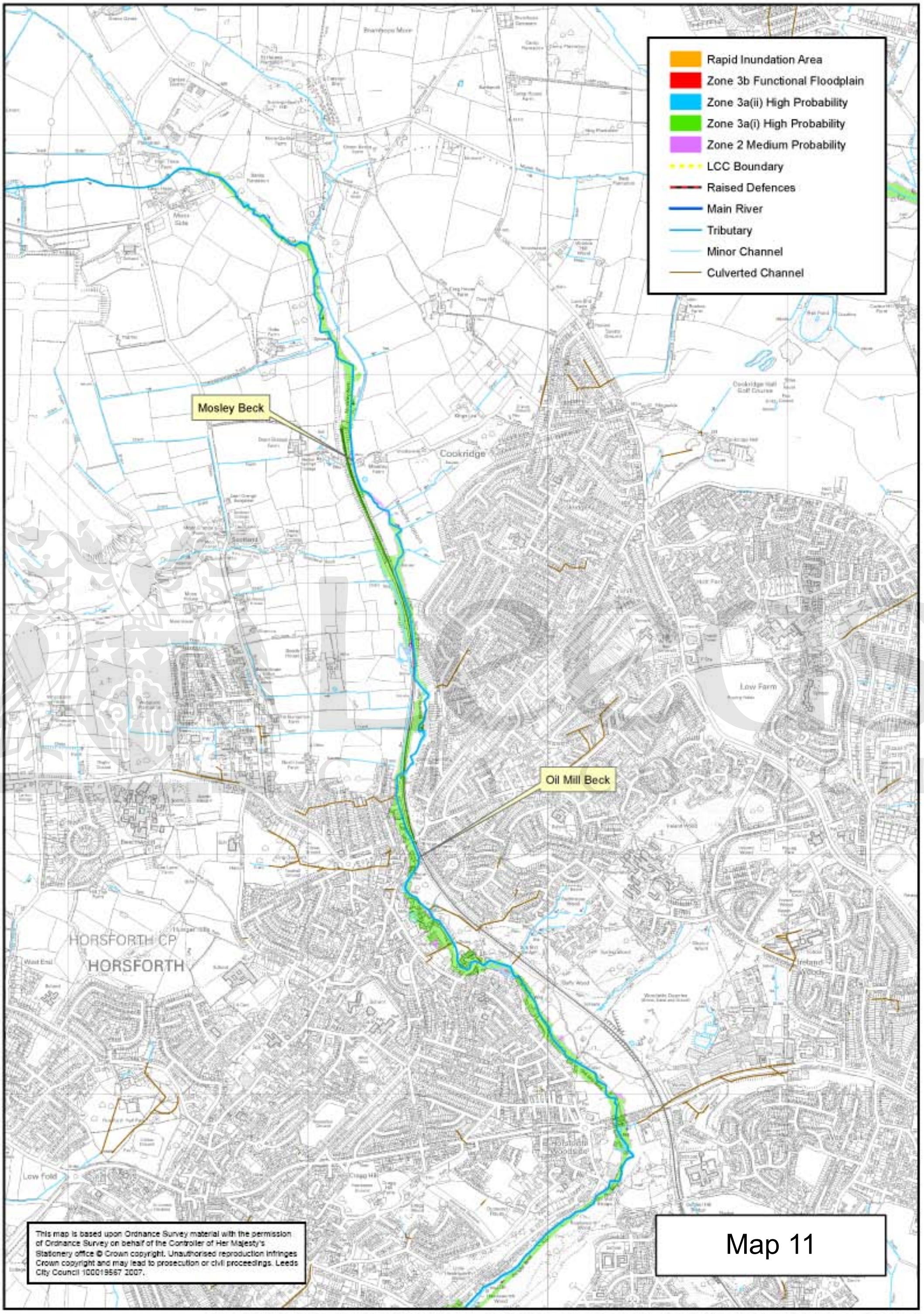
Henshaw Beck

YEADON

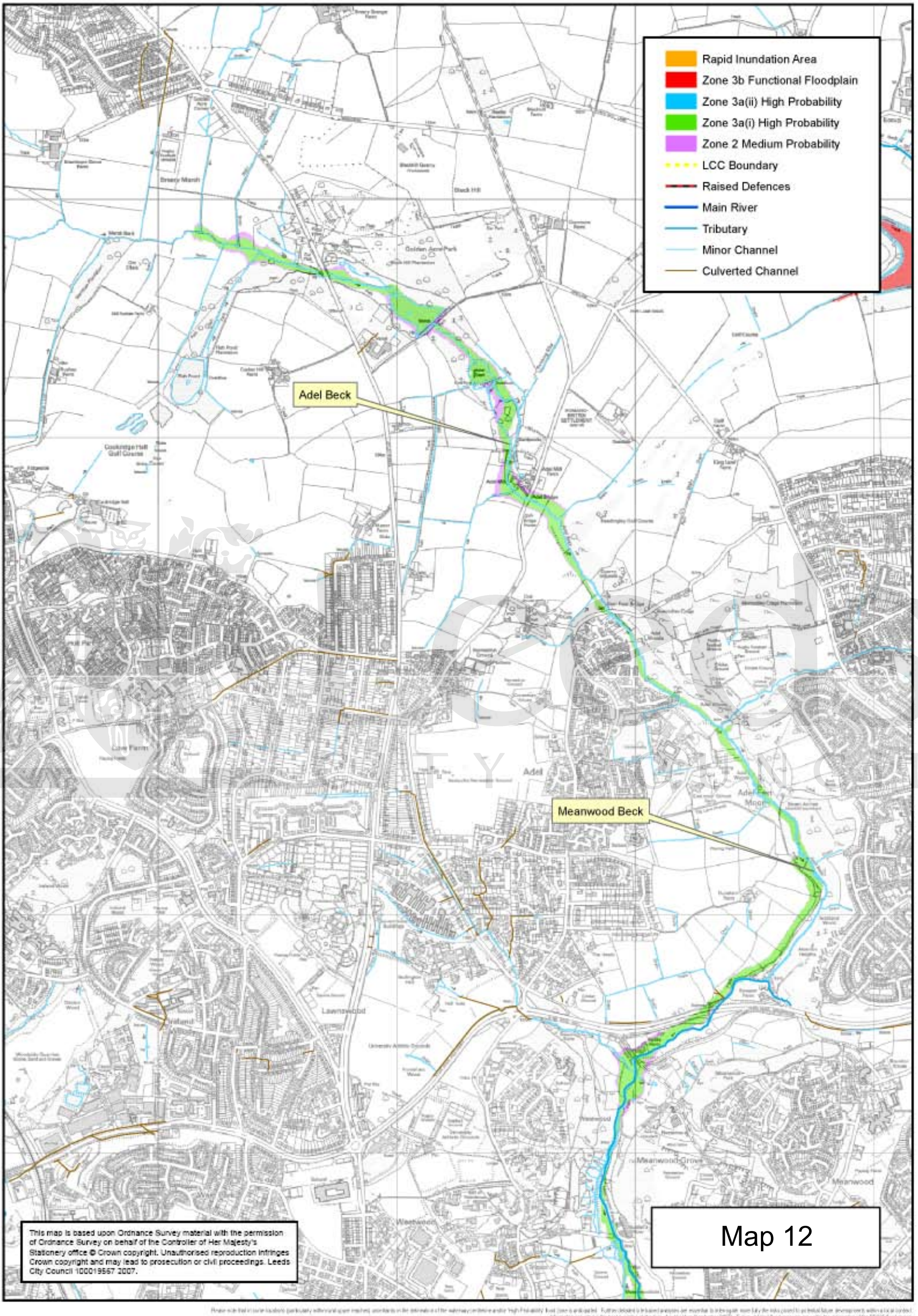
Rawdon

Map 10

Please note that in some locations (particularly within rural upper reaches), uncertainty in the delineation of the waterway corridors and/or High Probability flood zone is anticipated. Further detailed site based analysis are essential to interrogate more fully the risks posed to potential future development within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the FRCS flood zones.



Please note that in some locations (particularly within rural upper reaches), uncertainty in the delineation of the waterway centreline and/or 'High Probability' flood zone is anticipated. Further detailed site based analysis are essential to interrogate more fully the risks posed to potential future development within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the FRZ3 flood zones.



Please note that in some locations (particularly watercourse open reaches) boundaries on the interface of the waterway centreline and/or High Probability flood zone is anticipated. Further detailed hydraulic analysis are essential to investigate more fully the risks posed to potential future development within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the extent/size of the FRCS flood zones.

Stank Beck

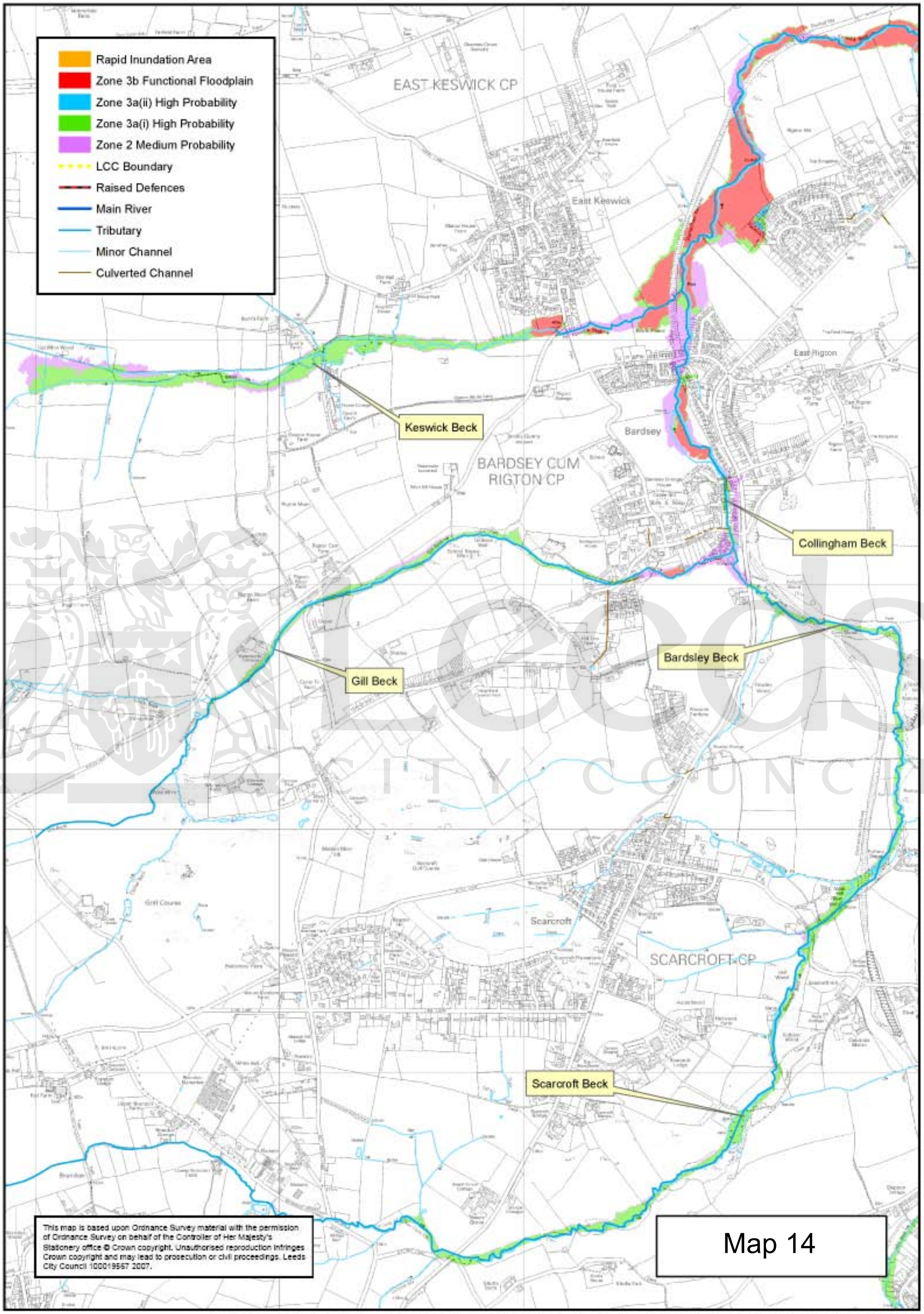
Eccup Beck

Eccup Reservoir

Alwoodley Park

Rapid Inundation Area
Zone 3b Functional Floodplain
Zone 3a(ii) High Probability
Zone 3a(i) High Probability
Zone 2 Medium Probability
LCC Boundary
Raised Defences
Main River
Tributary
Minor Channel
Culverted Channel

Map 13


Rapid Inundation Area
Zone 3b Functional Floodplain
Zone 3a(ii) High Probability
Zone 3a(i) High Probability
Zone 2 Medium Probability
LCC Boundary
Raised Defences
Main River
Tributary
Minor Channel
Culverted Channel
EAST KESWICK CP
East Keswick
East Rigton
Bardsey
BARDSEY CUM RIGTON CP
SCARCROFT CP
Scarcroft
Keswick Beck
Collingham Beck
Bardsley Beck
Gill Beck
Scarcroft Beck
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Map 14

Rapid Inundation Area
Zone 3b Functional Floodplain
Zone 3a(ii) High Probability
Zone 3a(i) High Probability
Zone 2 Medium Probability
LCC Boundary
Raised Defences
Main River
Tributary
Minor Channel
Culverted Channel

Milner Beck

Mill Beck

WOTHERSOME CP

THORNER CP

Thorner

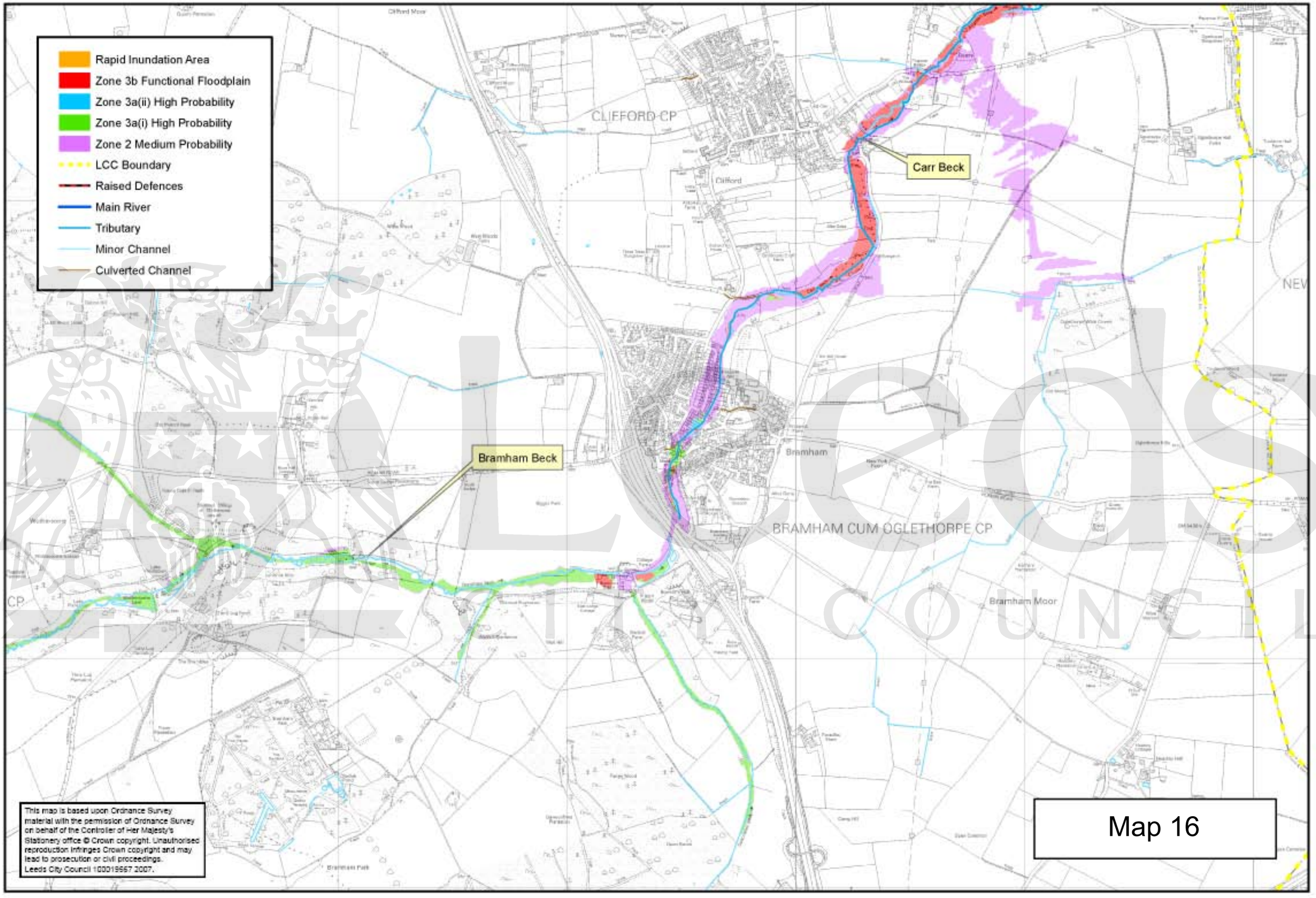
Thorner Moor

Wotherstone

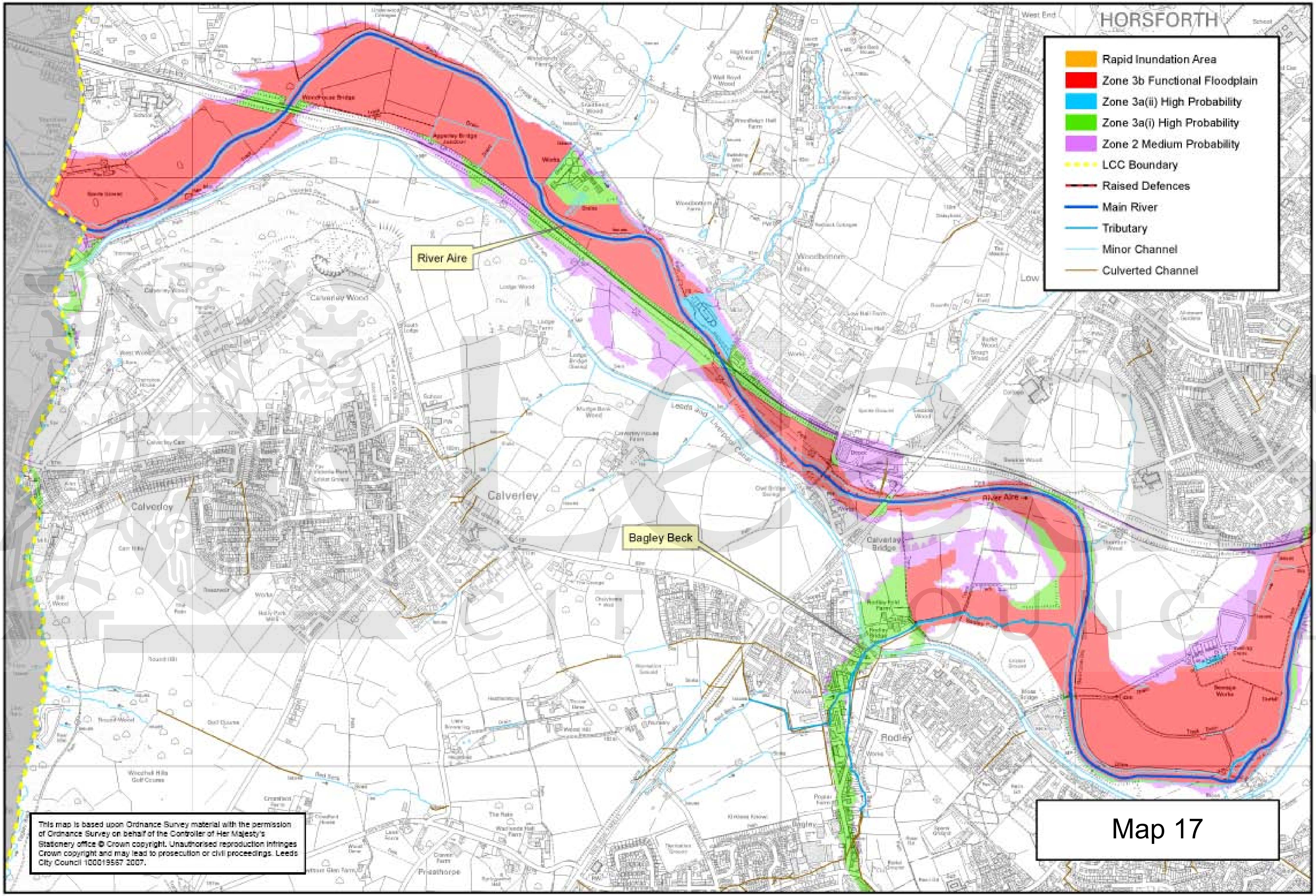
Rothley

Map 15

Please note that in some locations (particularly within rural upper reaches), uncertainty in the delineation of the waterway centreline and/or High Probability flood zone is anticipated. Further detailed site based analysis are essential to interrogate more fully the risks posed to potential future development within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the FRZ/3 flood zones.



Please note that in some locations (particularly within rural upper reaches) uncertainty in the delineation of the waterway centreline and/or 'High Probability' flood zone is anticipated. Further detailed site based analyses are essential to interrogate more fully the risks posed to potential future developments within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the FP525 flood zones.



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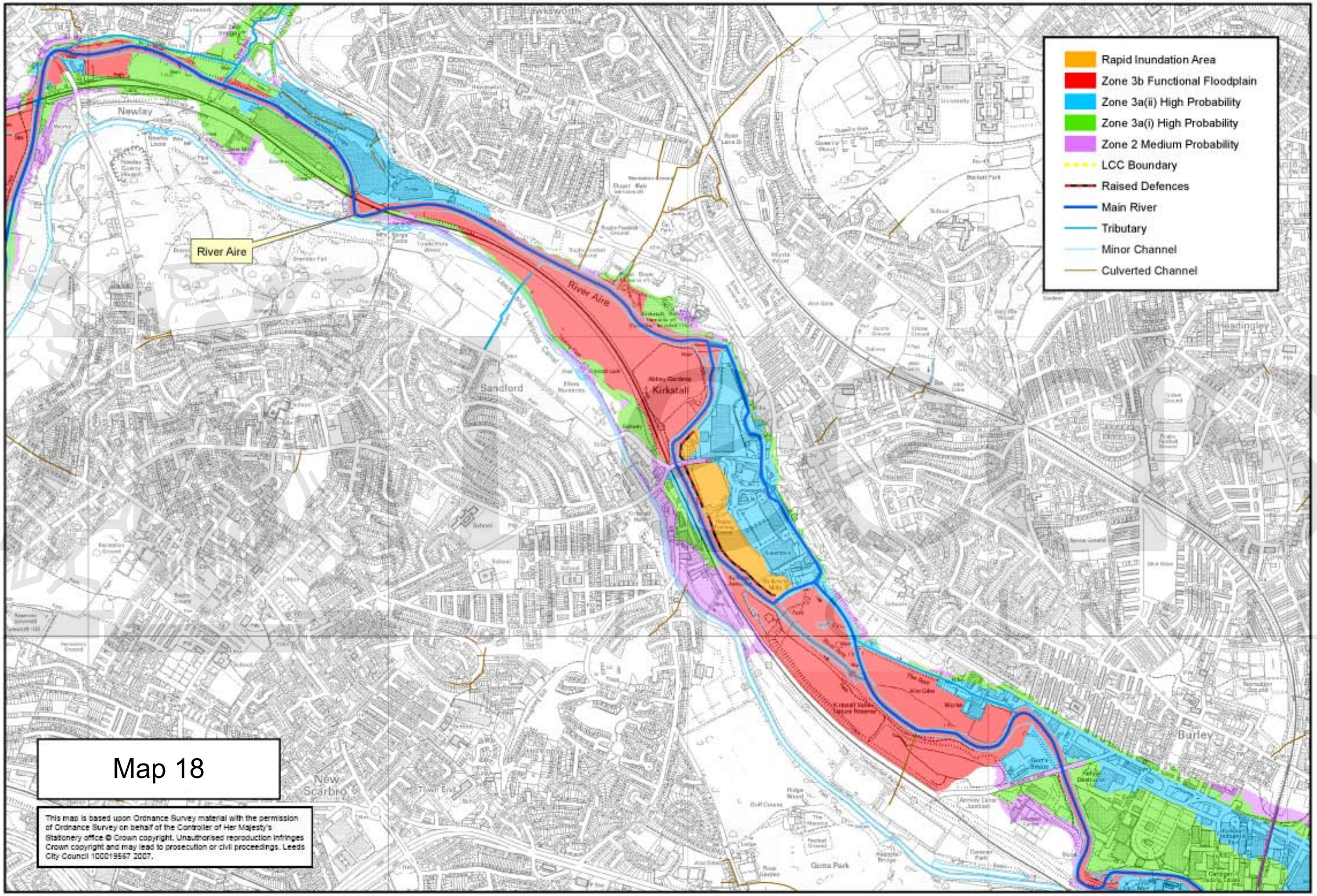
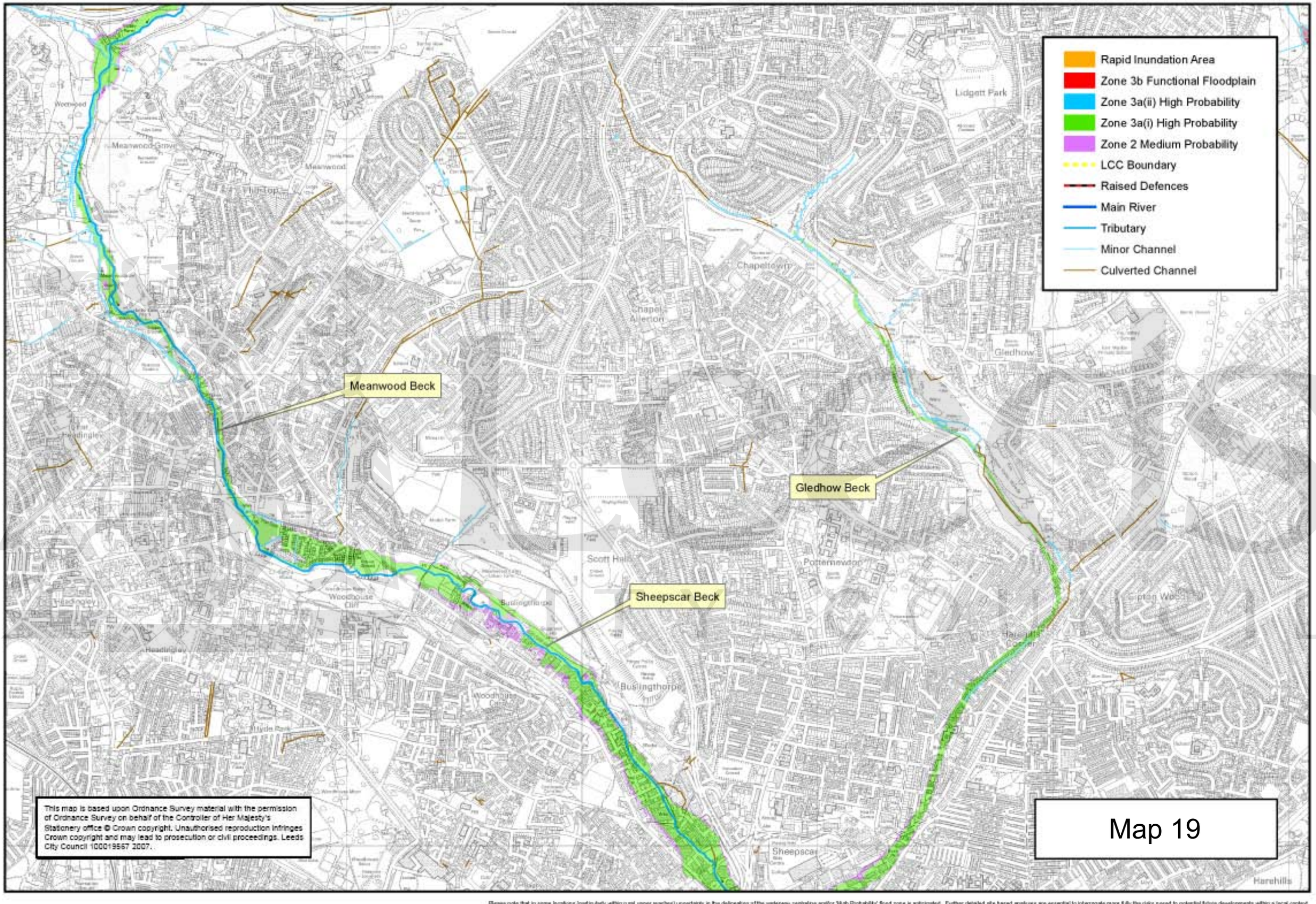


Map 18

Please note that in some locations (particularly within rural upper reaches) uncertainty in the delineation of the waterway centreline and/or 'High Probability' flood zone is anticipated. Further detailed site based analyses are essential to interrogate more fully the risks posed to potential future developments within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the PPS25 flood zones.



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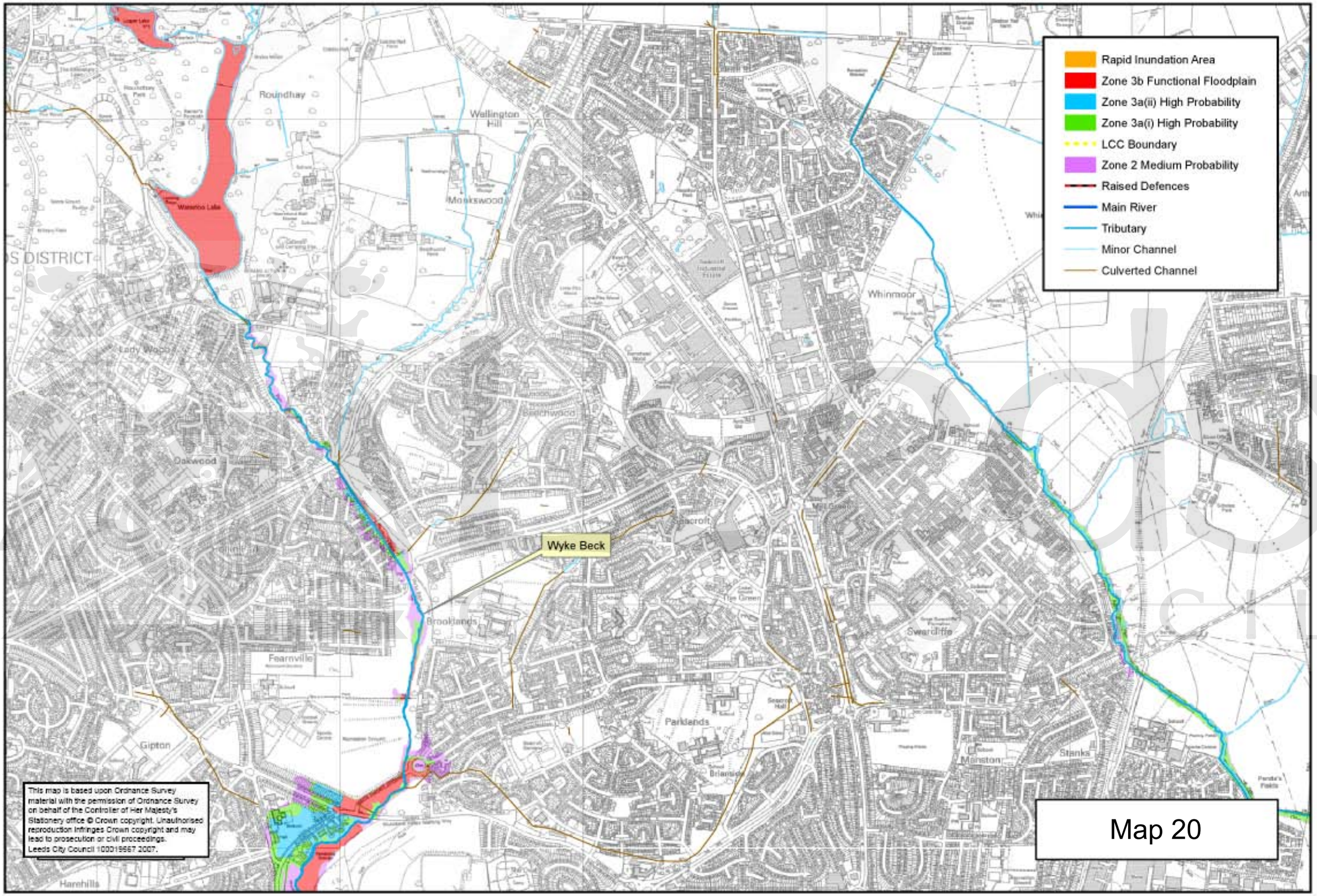

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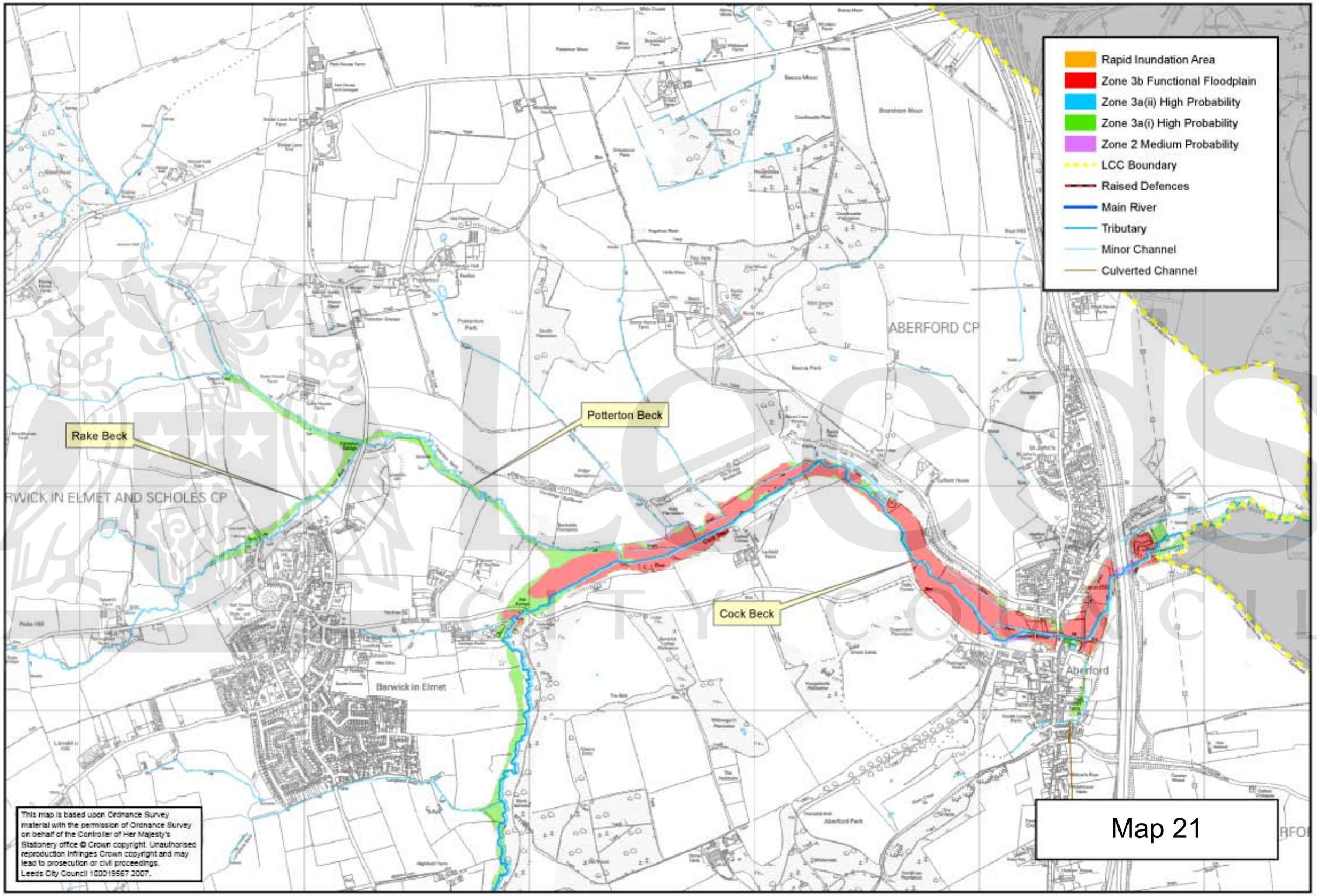


Please note that in some locations (particularly within rural upper reaches) uncertainty in the delineation of the waterway centreline and/or 'High Probability' flood zone is anticipated. Further detailed site based analyses are essential to interrogate more fully the risks posed to potential future developments within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the FP1&2S flood zones.

Rapid Inundation Area
Zone 3b Functional Floodplain
Zone 3a(ii) High Probability
Zone 3a(i) High Probability
Zone 2 Medium Probability
LCC Boundary
Raised Defences
Main River
Tributary
Minor Channel
Culverted Channel

Bagley Beck

Pudsey Beck

PUDSEY

Wood Nook

Bradford Moor

Tyersal

Belle Isle

Bound Hill

Windy Hill

Westroyd Hill

Bankhouse

Farnley

Stanningley

Swinnow

Kent

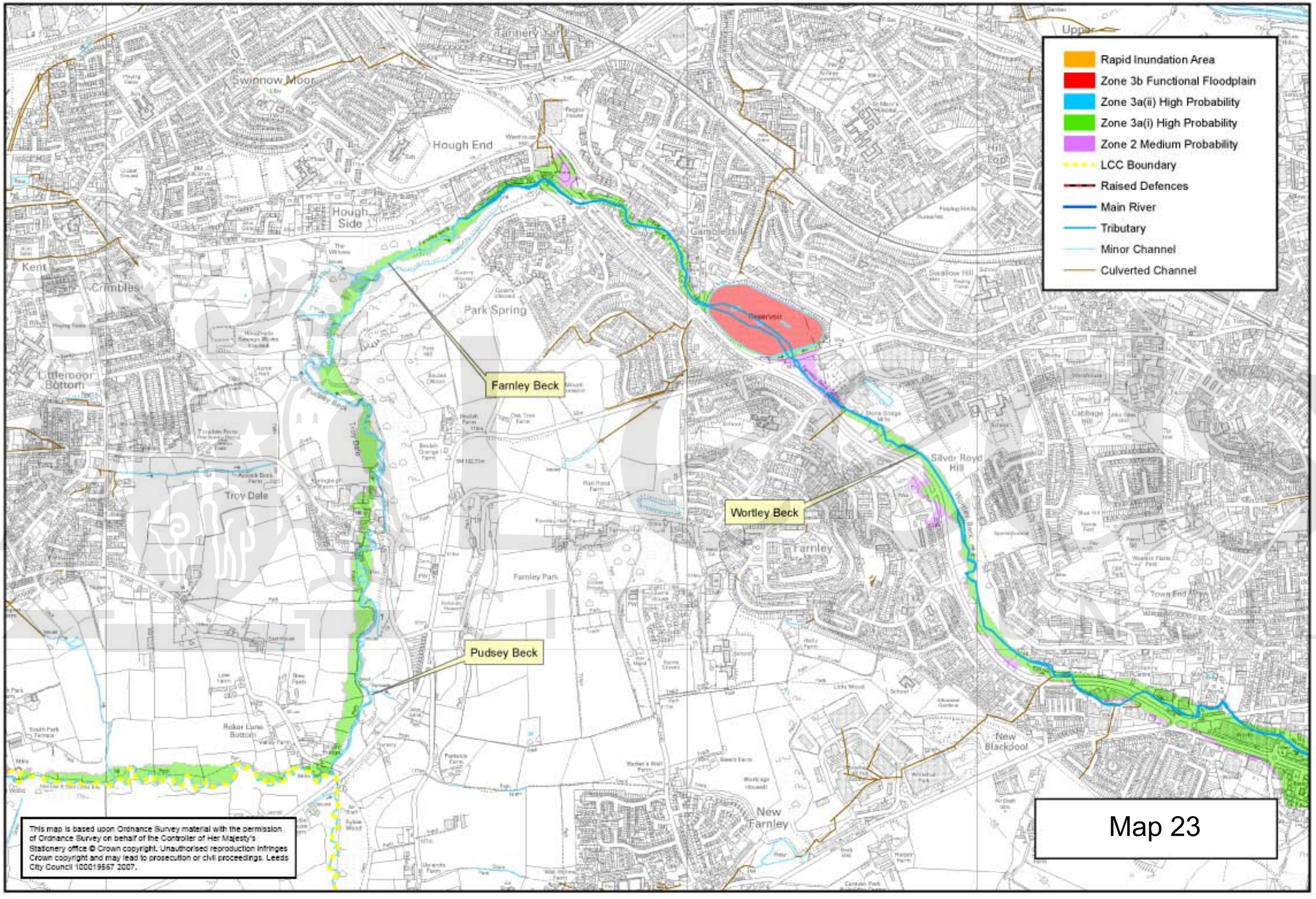
Littlemoor Bottom

Halfpot

Black Carr

Map 22

Please note that in some locations (particularly within rural upper reaches) uncertainty in the delineation of the waterway centreline and/or 'High Probability' flood zone is anticipated. Further detailed site based analyses are essential to interrogate more fully the risks posed to potential future developments within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the PPS25 flood zones.



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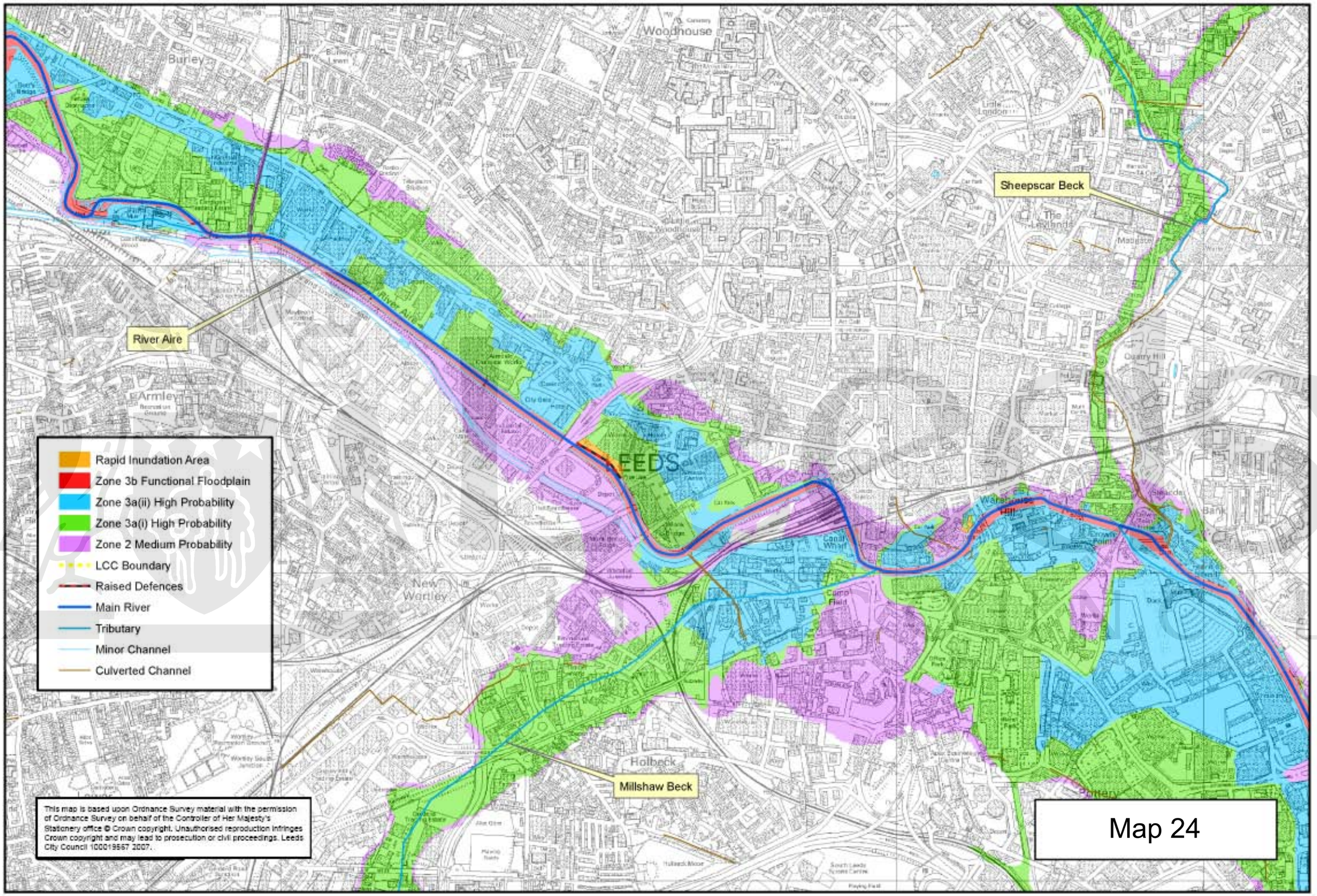

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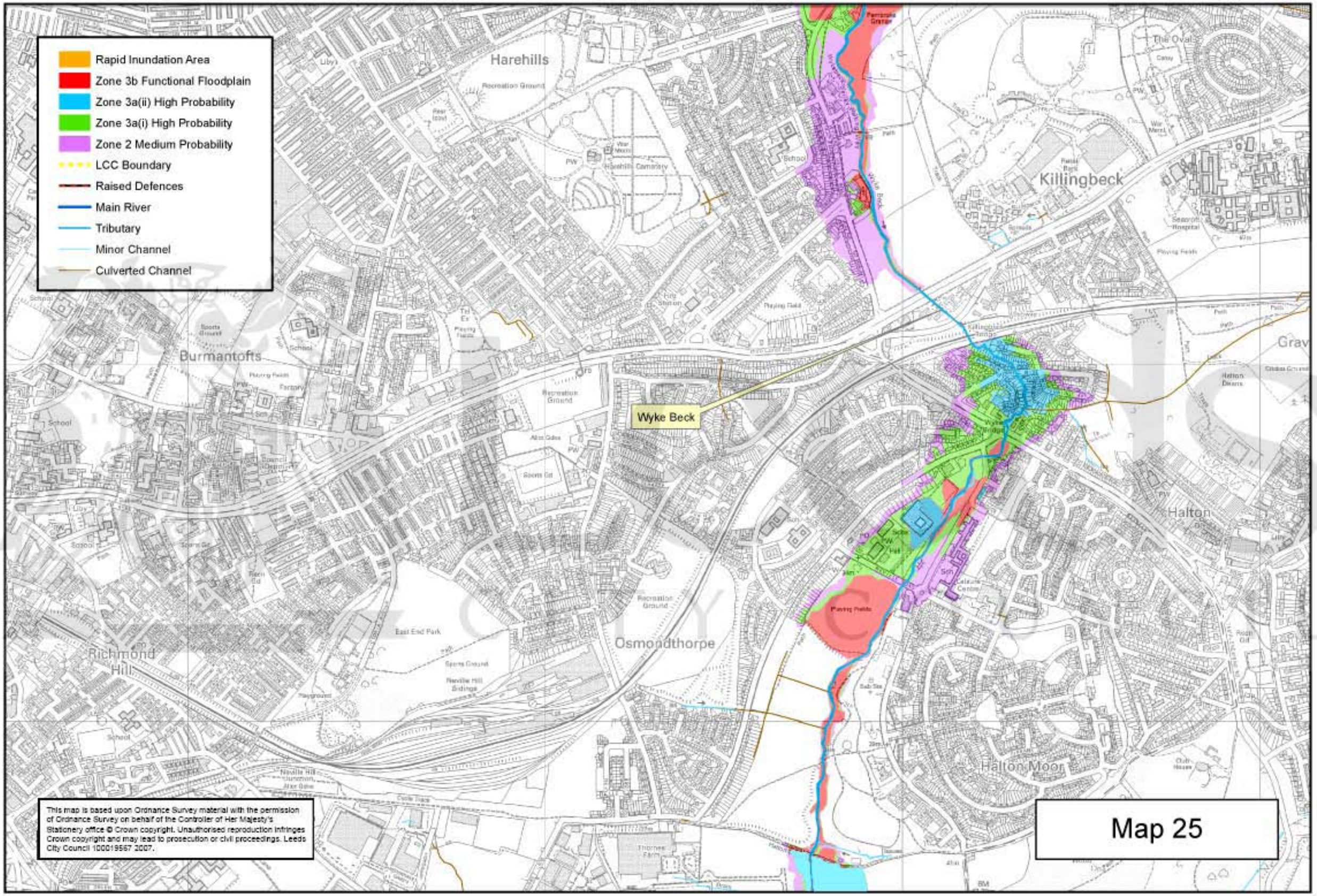

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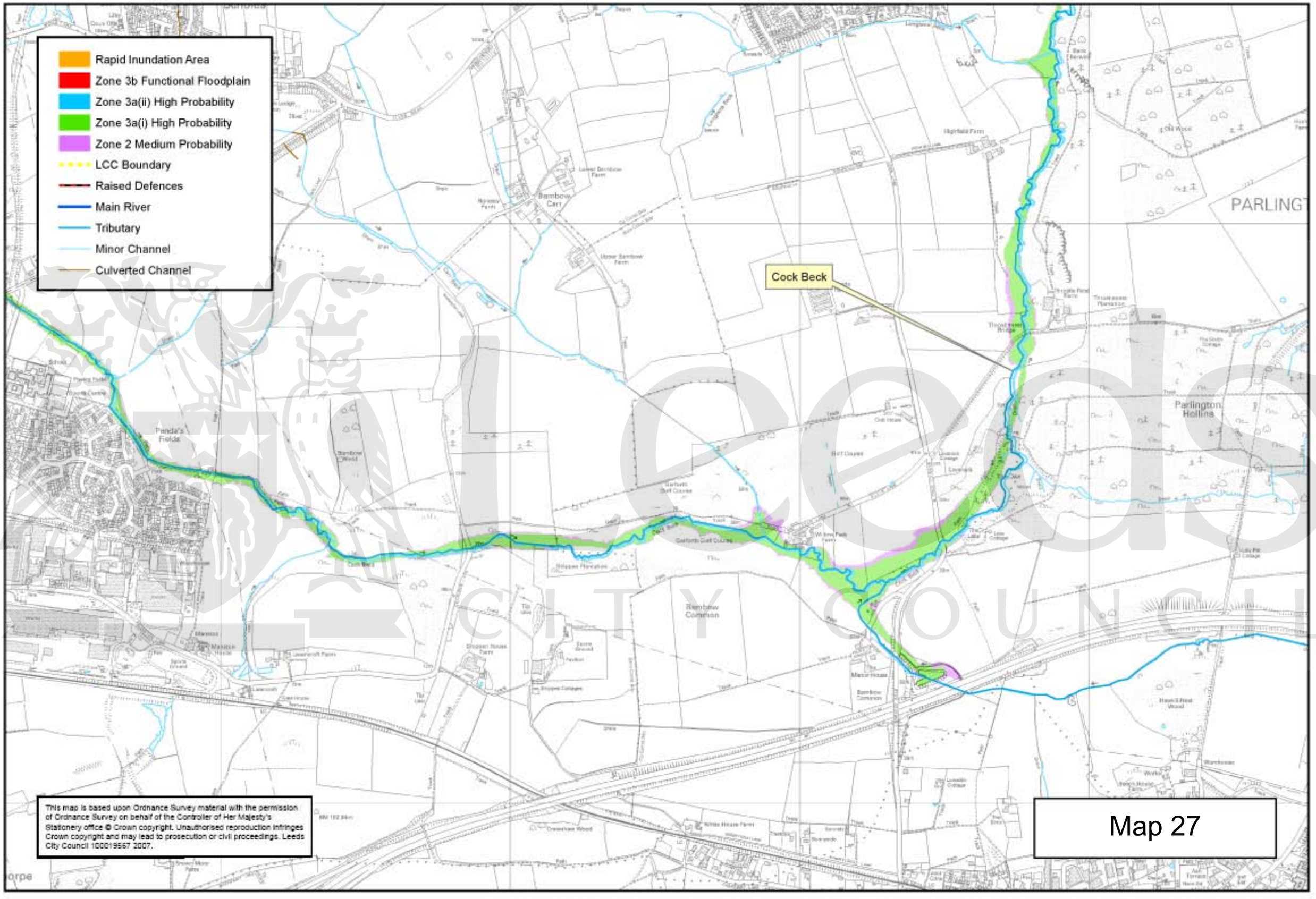
Rapid Inundation Area
Zone 3b Functional Floodplain
Zone 3a(ii) High Probability
Zone 3a(i) High Probability
Zone 2 Medium Probability
LCC Boundary
Raised Defences
Main River
Tributary
Minor Channel
Culverted Channel

Gross Gates
Graveleythorpe
Whitkirk
Austhorpe
Whitkirk Lane End
Colton
Temple Newsam Park
Golf Course
Avenue Wood

Map 26

Please note that in some locations (particularly within rural upper reaches), uncertainty in the delineation of the waterway centreline and/or 'High Probability' flood zone is anticipated. Further detailed site based analysis are essential to interrogate more fully the risks posed to potential future development within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the FRZ3b flood zones.



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Rapid Inundation Area
Zone 3b Functional Floodplain
Zone 3a(ii) High Probability
Zone 3a(i) High Probability
Zone 2 Medium Probability
LCC Boundary
Raised Defences
Main River
Tributary
Minor Channel
Culverted Channel

Parlington Park
Hook Moor
MICKLEFIELD CP
STURTON GRANGE CP
HUDDLESTON WITH NEWTHORPE CP
Sandygate
Old Micklefield
Micklefield
New Micklefield
Sheep Dike

Map 28

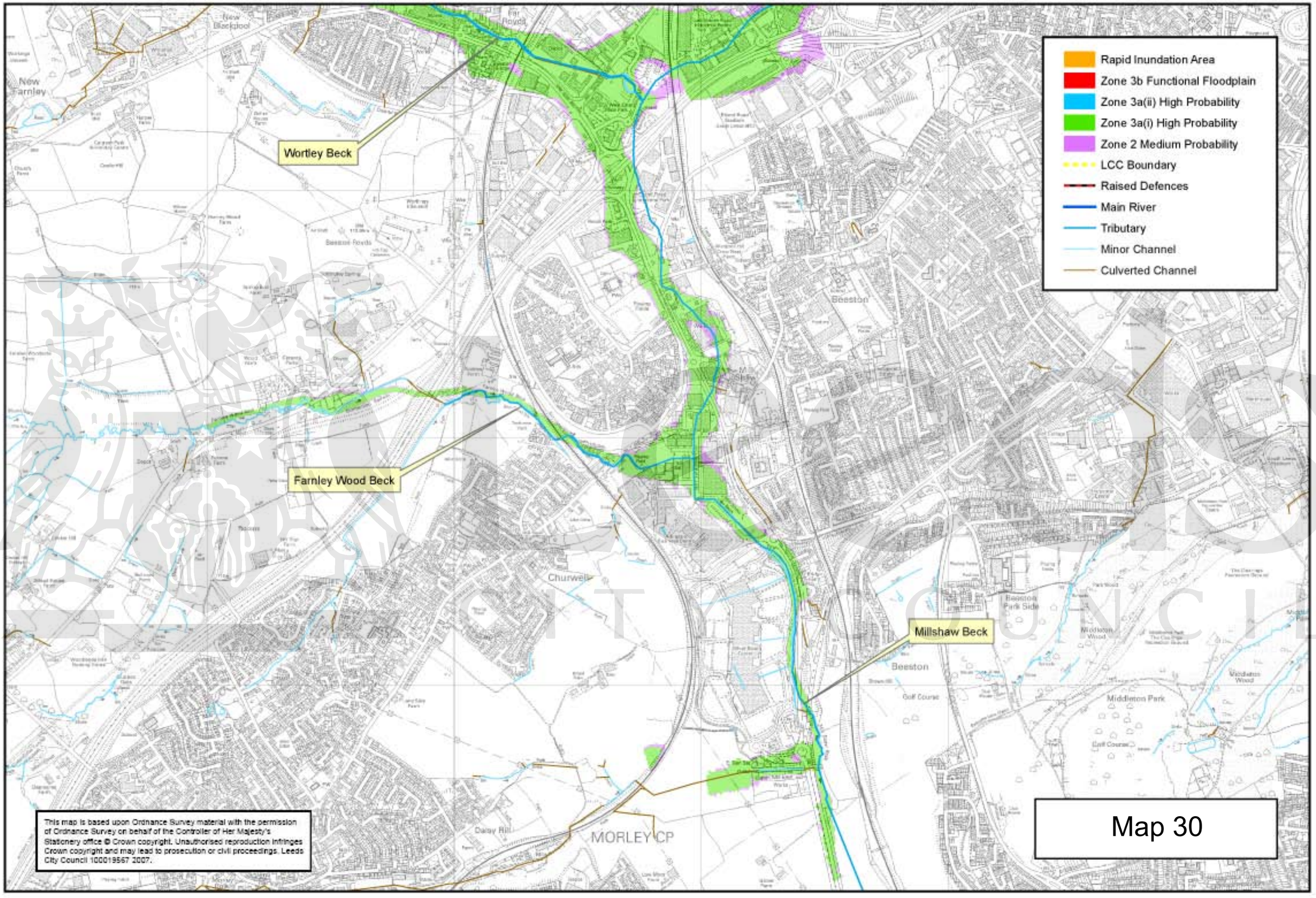
Please note that in some locations (particularly within rural upper reaches) uncertainty in the delineation of the waterway centreline and/or 'High Probability' flood zone is anticipated. Further detailed site based analyses are essential to interrogate more fully the risks posed to potential future developments within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the FP525 flood zones.

Rapid Inundation Area
Zone 3b Functional Floodplain
Zone 3a(ii) High Probability
Zone 3a(i) High Probability
Zone 2 Medium Probability
LCC Boundary
Raised Defences
Main River
Tributary
Minor Channel
Culverted Channel

Tong
Low Moor Side
Upper Moor Side
Gildersome
Drighlington
Pudsey
Birstall
Howden Clough
Upper Batley

Map 29

Please note that in some locations (particularly within rural upper reaches), uncertainty in the delineation of the waterway centreline and/or 'High Probability' flood zone is anticipated. Further detailed site based analysis are essential to interrogate more fully the risks posed to potential future development within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the PPG25 flood zones.



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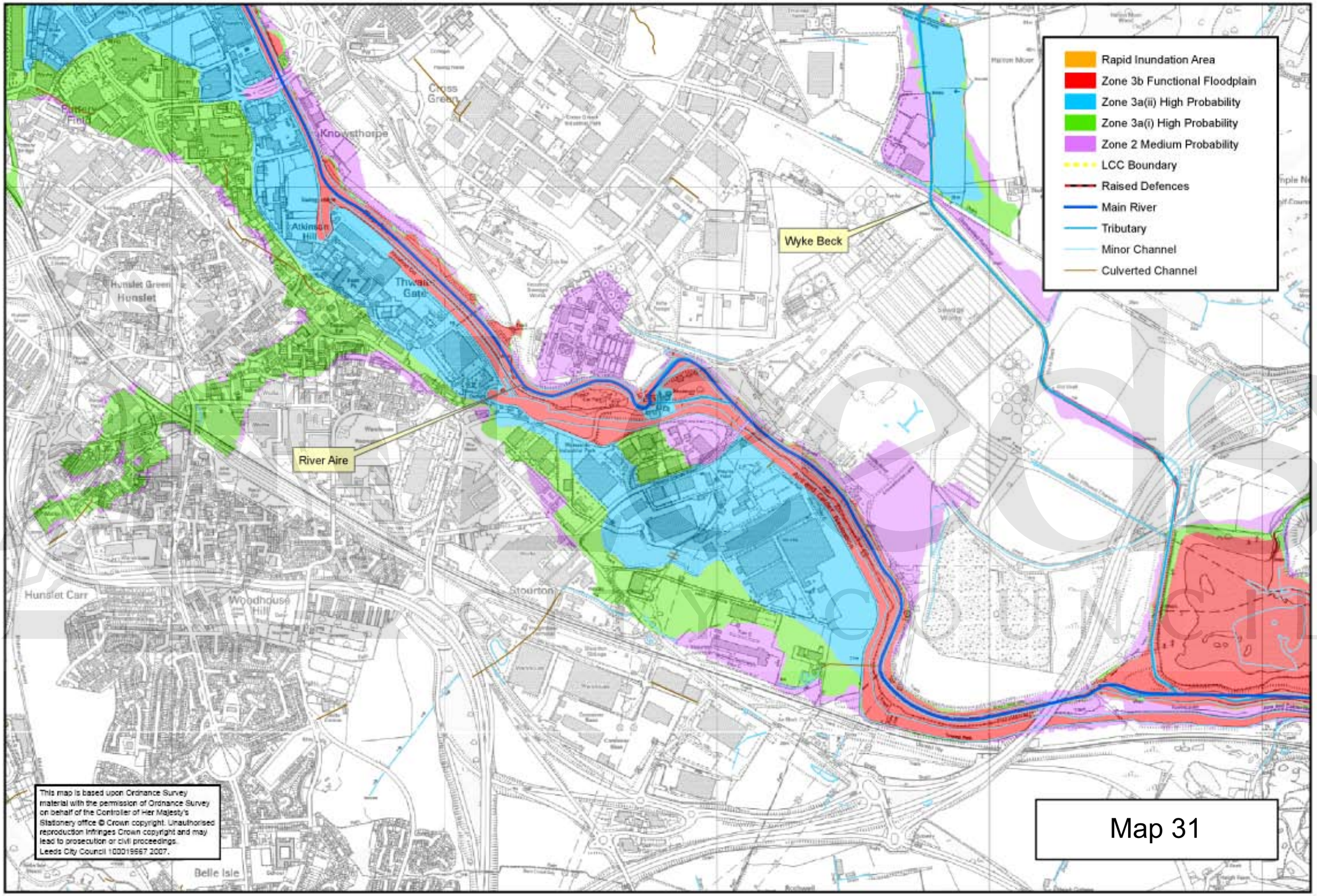

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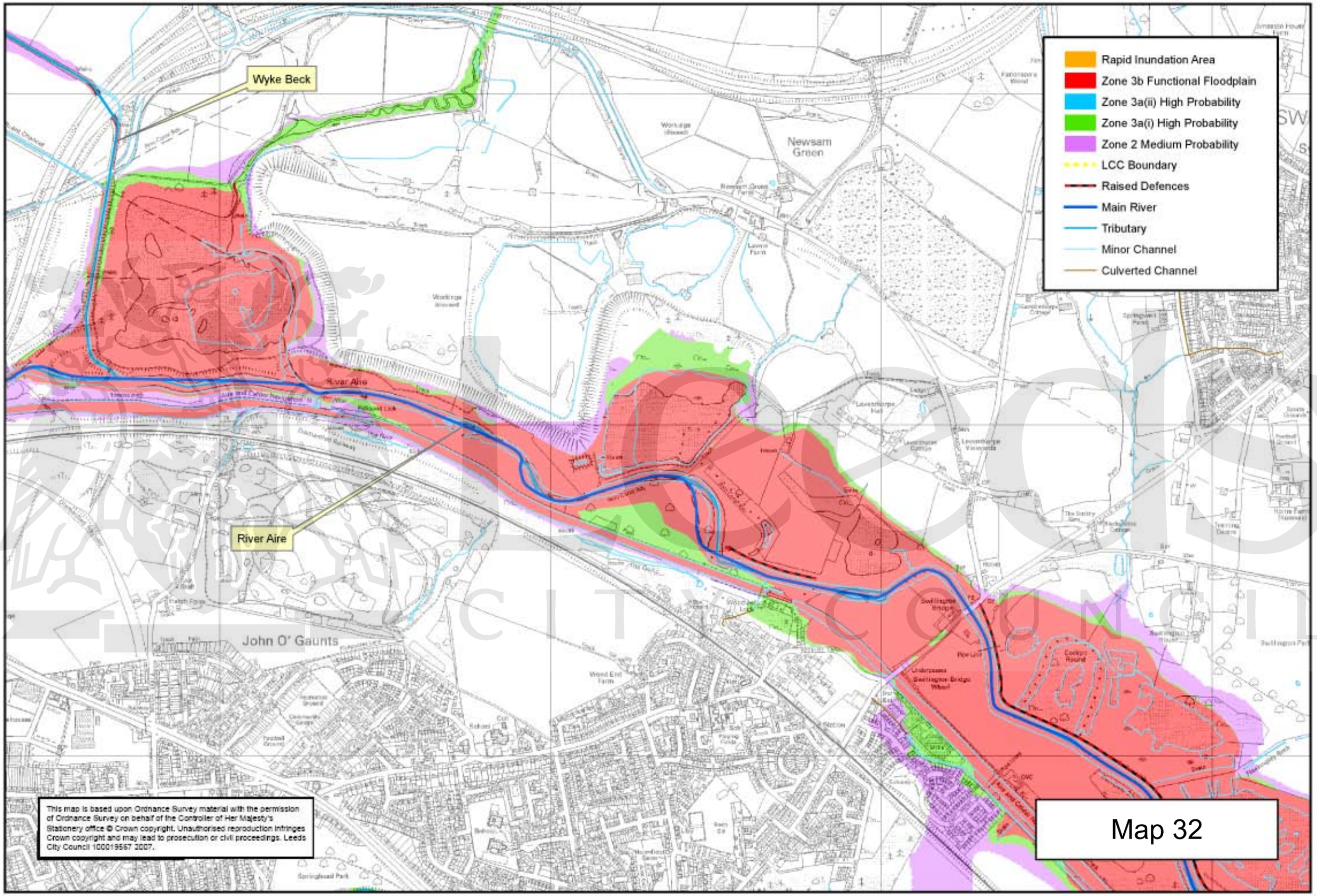


Please note that in some locations (particularly within rural upper reaches) uncertainty in the delineation of the waterway centreline and/or 'High Probability' flood zone is anticipated. Further detailed site based analyses are essential to interrogate more fully the risks posed to potential future developments within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the FP1525 flood zones.

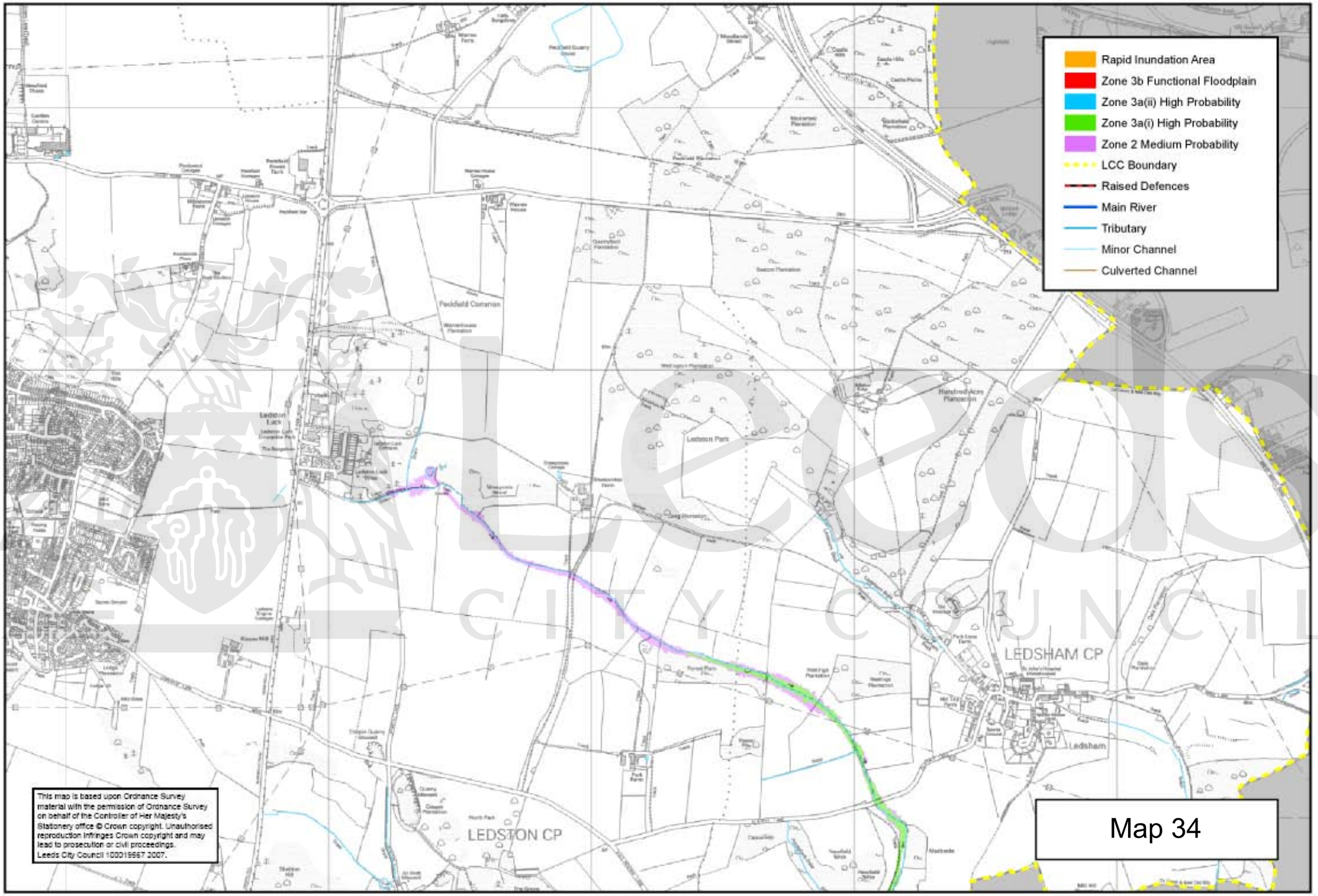
Rapid Inundation Area
Zone 3b Functional Floodplain
Zone 3a(ii) High Probability
Zone 3a(i) High Probability
Zone 2 Medium Probability
LCC Boundary
Raised Defences
Main River
Tributary
Minor Channel
Culverted Channel

Kippax Beck

GARFORTH
Church Garforth
West Garforth
Garforth Bridge
Lidgett
Barrowby Park
Hollinthorpe
SWILLINGTON CP
Swillington
Little Preston
Kippax
Moor Gate

Map 33

Please note that in some locations (particularly within rural upper reaches) uncertainty in the delineation of the waterway centreline and/or 'High Probability' flood zone is anticipated. Further detailed site based analyses are essential to interrogate more fully the risks posed to potential future developments within a local context. Information provided is the best available at the time of publication (September 2007). Future detailed flood mapping may alter the delineation of the PPS25 flood zones.



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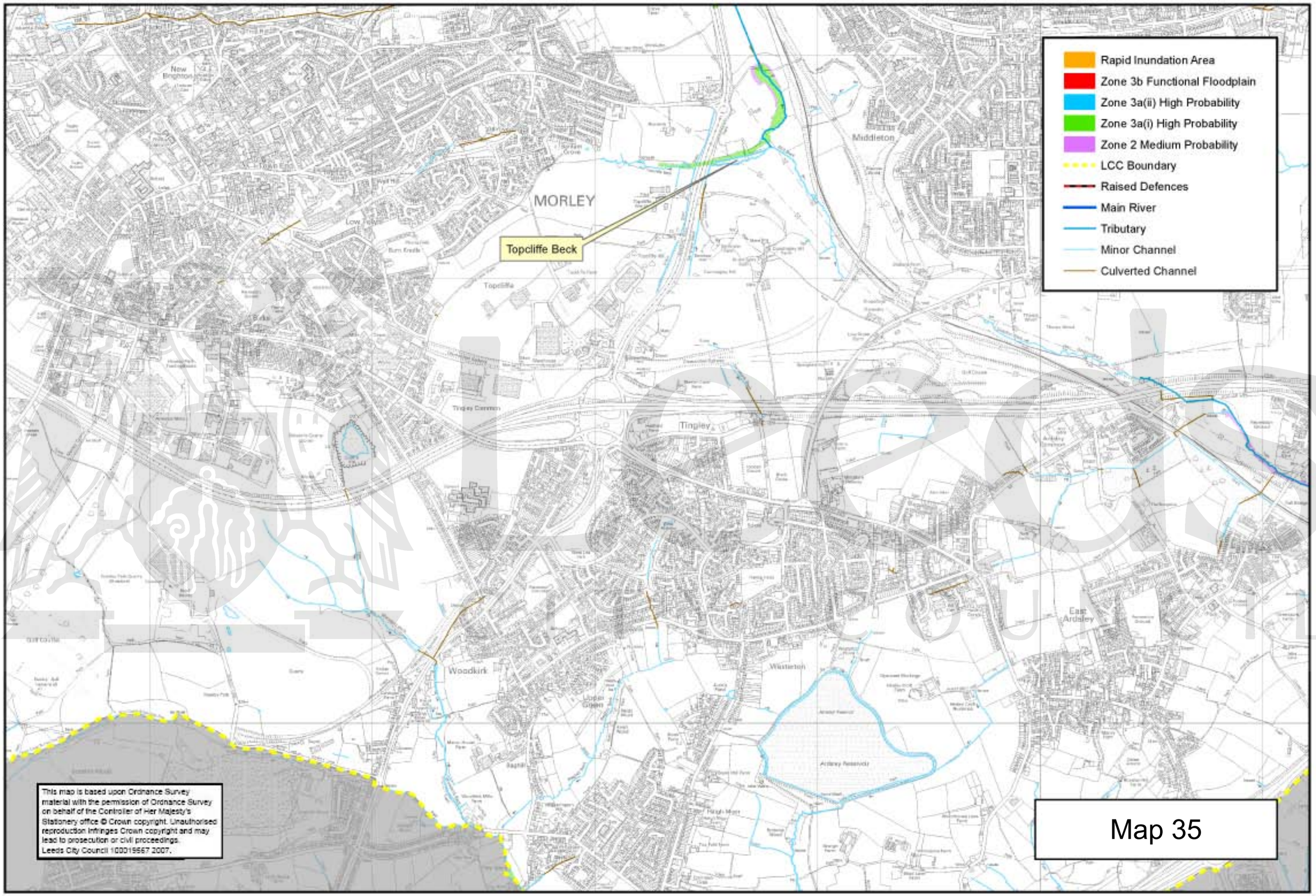

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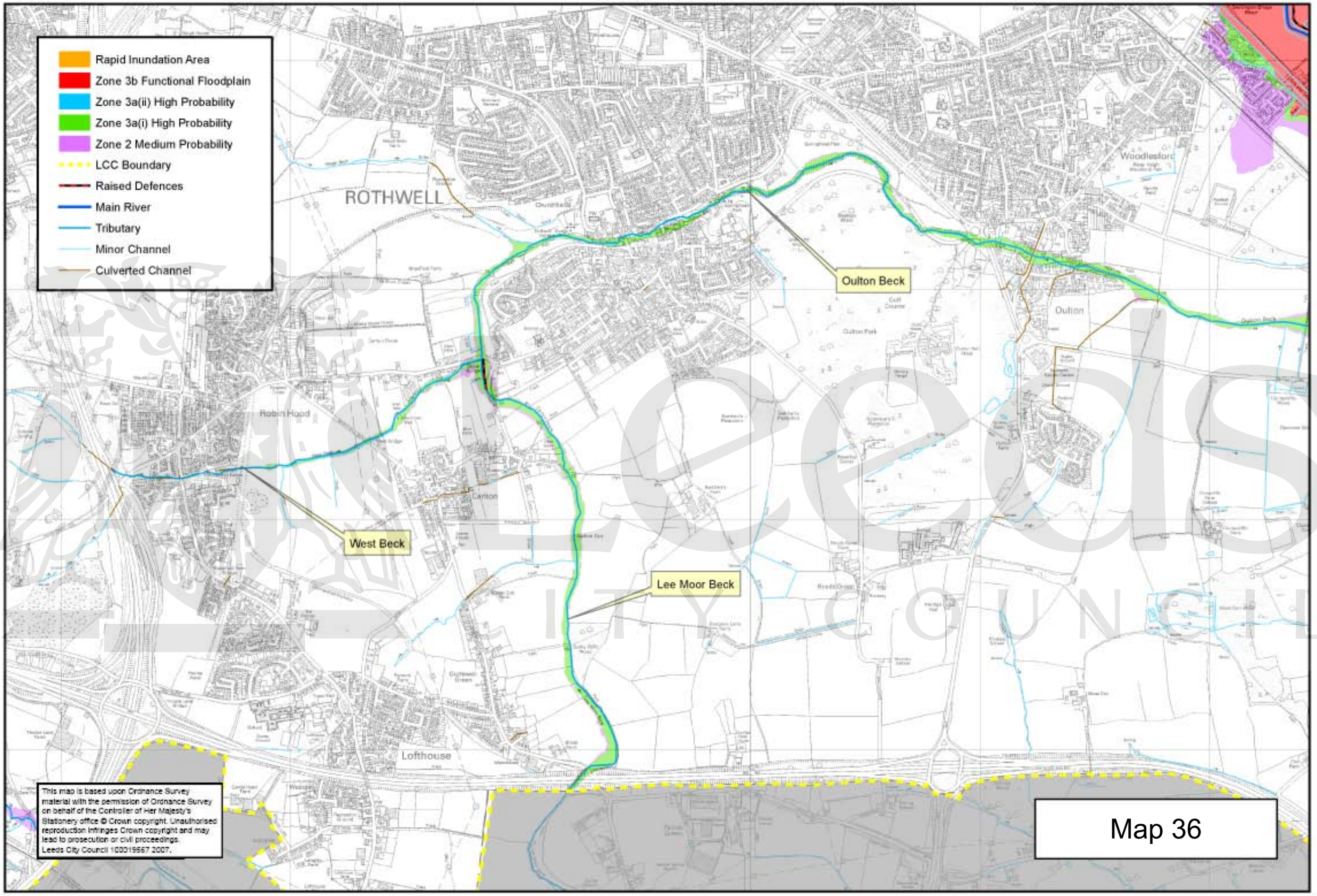

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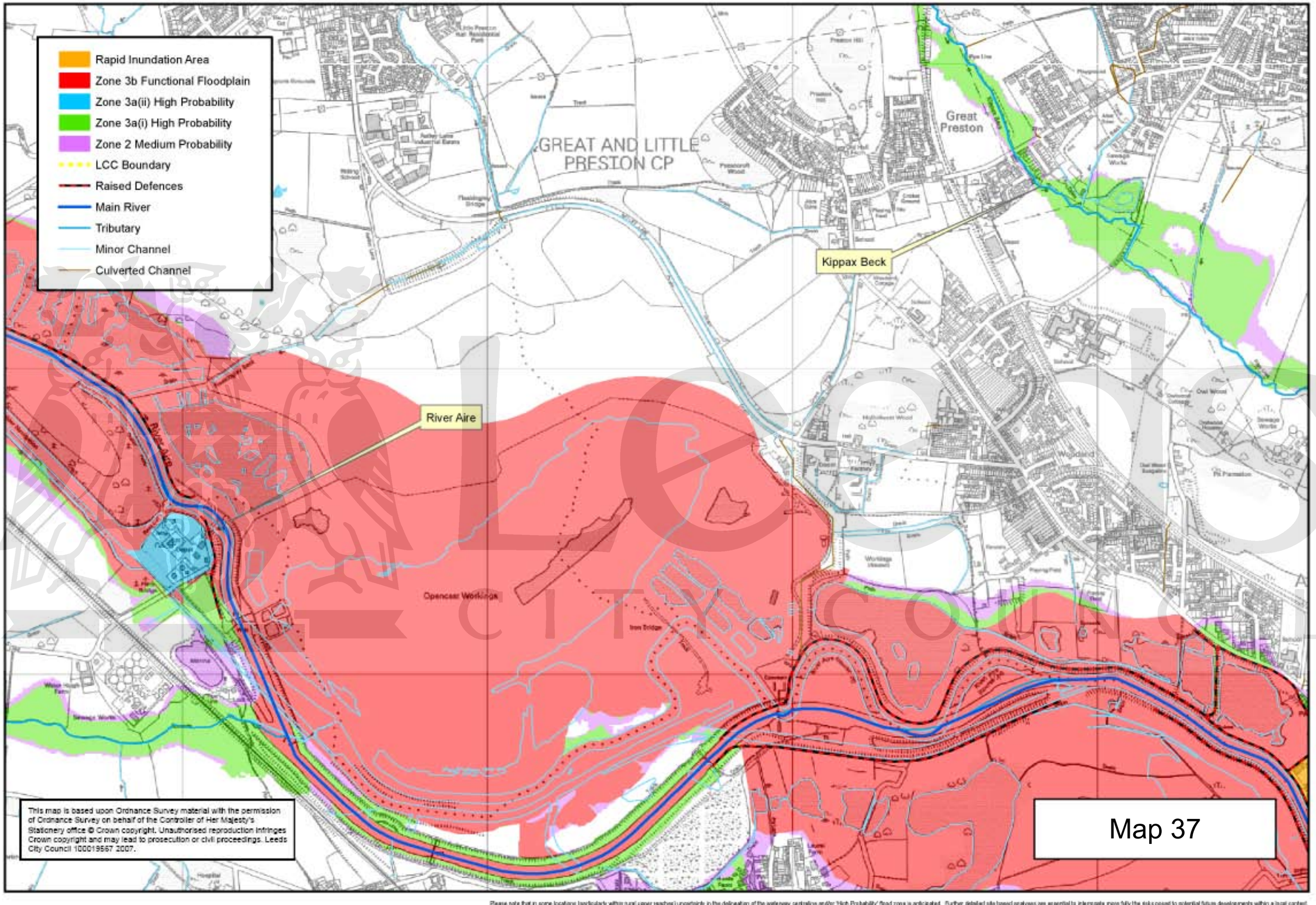

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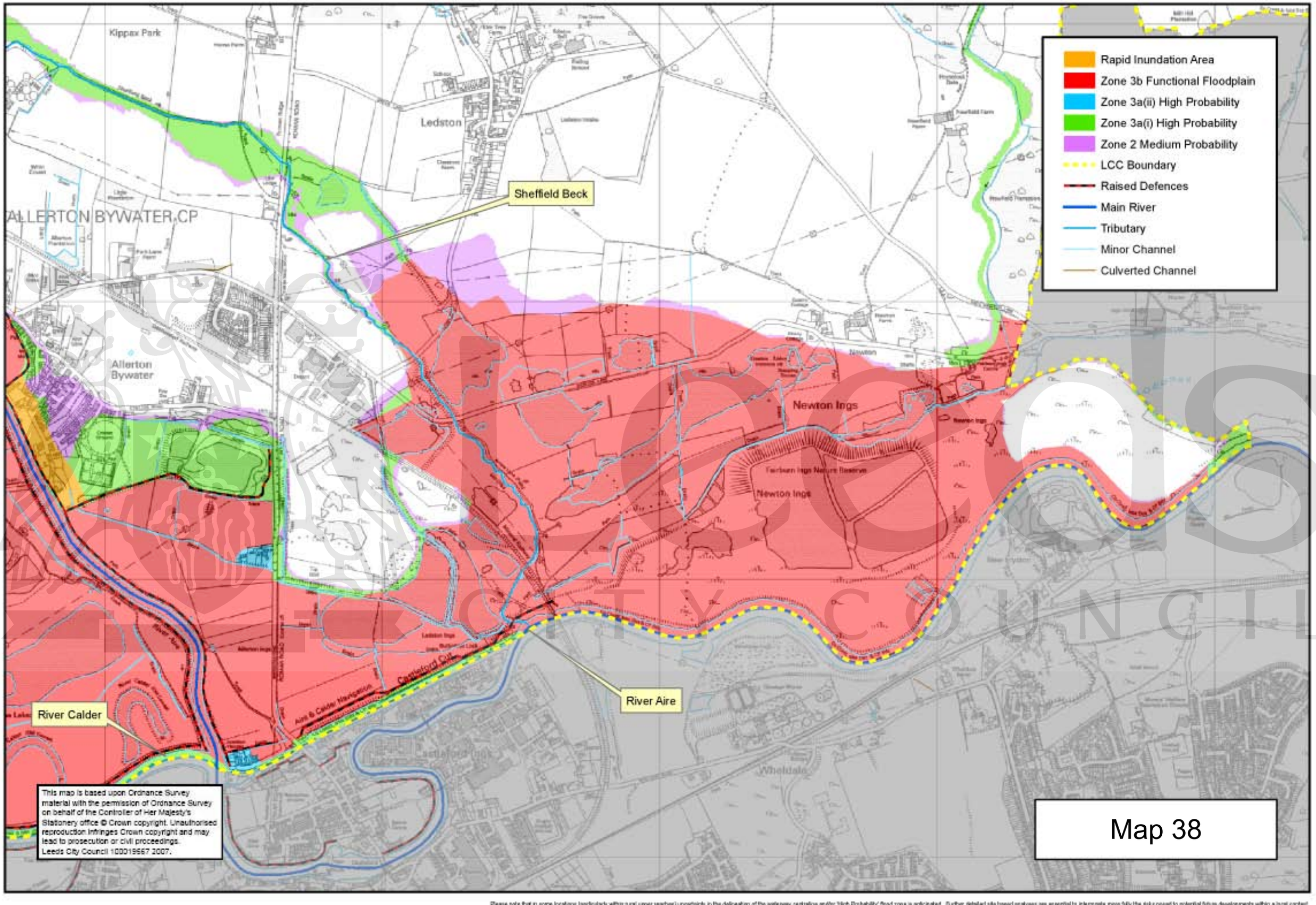

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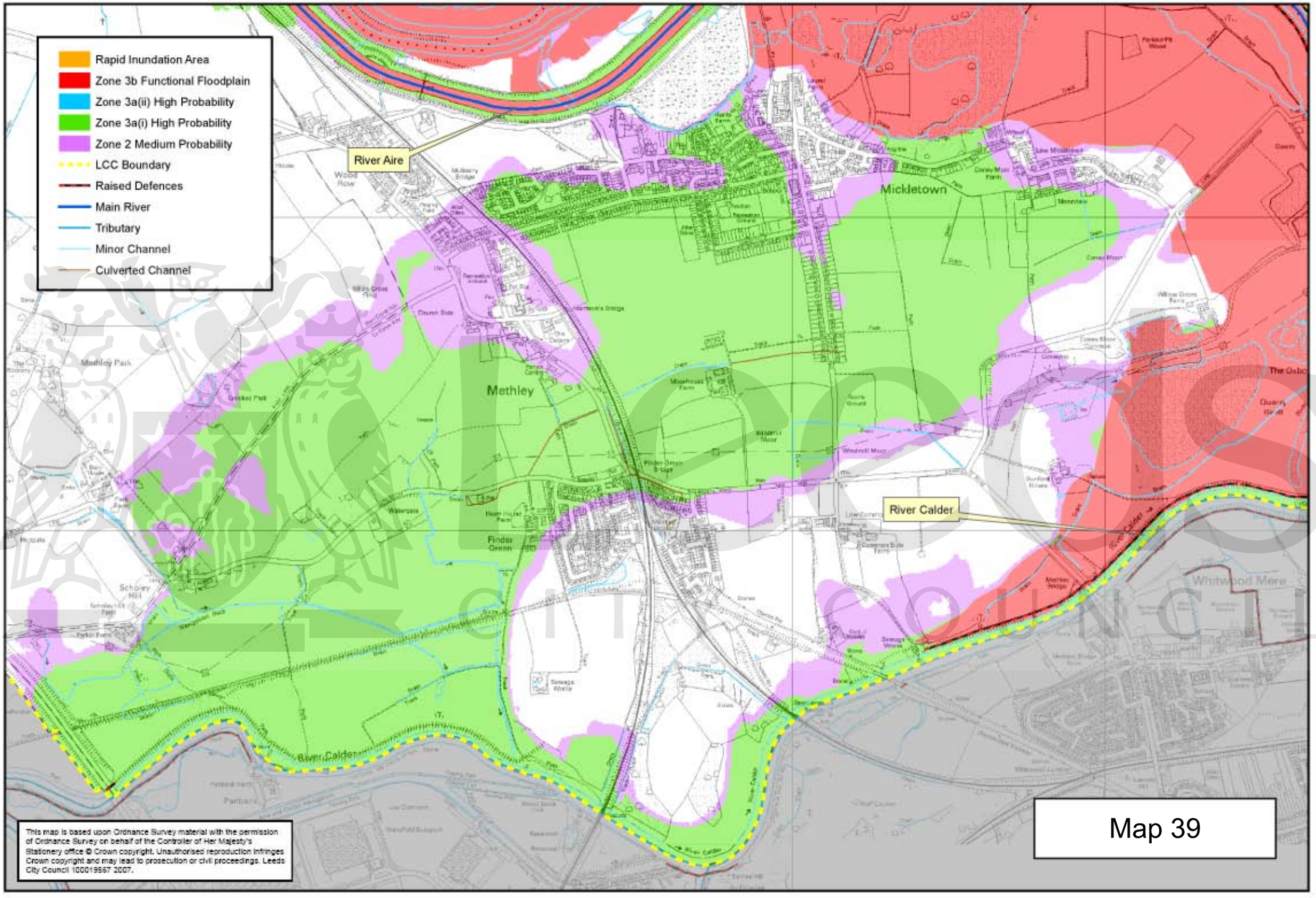

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Leeds CITY COUNCIL

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Core Strategy

Leeds Local Development Framework

Development Plan Document

Strategic Flood Risk Assessment

October 2007