URS

Milton Keynes Level 1 Strategic Flood Risk Assessment

Final Report

April 2015

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ABBREVIATIONS

ACRONYM	DEFINITION
ABD	Areas Benefiting from Defences
AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
AIMS	Asset Information Management System
AStSWF	Areas Susceptible to Surface Water Flooding
AWS	Anglian Water Services
BGDB	Bedford Group of Drainage Boards
BGS	British Geological Survey
CFMP	Catchment Flood Management Plan
CIRIA	Construction Industry Research and Information Association
DA	Designated Area (Milton Keynes)
Defra	Department for Environment, Flood and Rural Affairs
DPD	Development Plan Document
EU	European Union
FCERM	Flood and Coastal Erosion Risk Management
FEH	Flood Estimation Handbook
FRA	Flood Risk Assessment
FRMP	Flood Risk Management Plan
FWMA	Flood and Water Management Act 2010
GIS	Geographic Information Systems
HCA	Homes and Communities Agency
IDB	Internal Drainage Board
LFRMS	Local Flood Risk Management Strategy
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
LRF	Local Resilience Forum

MKC	Milton Keynes Council
MKPT	Milton Keynes Parks Trust
NPPF	National Planning Policy Framework
NPPG	National Planning Policy Guidance
PFRA	Preliminary Flood Risk Assessment
PPS25	Planning Policy Statement 25
RSS	Regional Spatial Strategies
SFRA	Strategic Flood Risk Assessment
SLA	Strategic Land Allocation
SoP	Standard of Protection
SPG	Supplementary Planning Guidance
SPZ	Source Protection Zone
SuDS	Sustainable Drainage Systems
uFMfSW	Updated Flood Map for Surface Water
UKCP09	UK Climate Projections 2009

GLOSSARY OF TERMS

GLOSSARY	DEFINITION
1D Hydraulic Model	Hydraulic model which computes flow in a single dimension, suitable for representing systems with a defined flow direction such as river channels, pipes and culverts
2D Hydraulic Model	Hydraulic model which computes flow in multiple dimensions, suitable for representing systems without a defined flow direction including topographic surfaces such as floodplains
Annual exceedance probability	Annual exceedance probability of flood event occurring in any one year, expressed as a percentage. For example, a 1% annual probability event has a 1 in 100 chance of occurring in any year.
Areas Benefitting from Defences (ABD)	Areas Benefiting from Flood Defences shows those areas that would benefit from the presence of formal flood defences in the event of flooding from rivers with a 1% (1 in 100) chance in any given year. If the defences were not there, these areas would be flooded.
Asset Information Management System (AIMS)	Environment Agency database of assets associated with main rivers including defences, structures and channel types. Information regarding location, standard of service, dimensions and condition.
Aquifer	A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
Attenuation	In the context of this report - the storing of water to reduce peak discharge of water.
Catchment Flood Management Plan	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions. For fluvial events a 20% increase in river flow is applied and for rainfall events, a 30% increase. These climate change values are based upon information within the National Planning Policy Framework (NPPF) and National Planning Practice Guidance (NPPG).
Culvert	A channel or pipe that carries water below the level of the ground.
Designated Area (DA)	The original area to be developed for the new town of Milton Keynes as set out in the 1967 New Town Designation Order. The DA is almost 9,000 hectares (22,000 acres) and includes the towns of Bletchley, Stony Stratford, Wolverton and New Bradwell.
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.
Exception Test	The Exception Test should be applied following the application of the Sequential Test. Conditions need to be met before the Exception Test can be applied.
Flood Defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Resilience	Measures that minimise water ingress and promotes fast drying and easy cleaning, to prevent any permanent damage.
Flood Resistant	Measures to prevent flood water entering a building or damaging its fabric. This has the same meaning as flood proof.
Flood Risk	The level of flood risk is the product of the frequency or likelihood of the flood events and their consequences (such as loss, damage, harm, distress and disruption).
Flood Zone	Flood Zones show the probability of flooding, ignoring the presence of existing defences
Fluvial	Relating to the actions, processes and behaviour of a watercourse (river or stream).
Freeboard	Height of flood defence crest level (or building level) above designed water level

GLOSSARY	DEFINITION
Functional Floodplain	Land where water has to flow or be stored in times of flood.
Groundwater	Water that is in the ground, this is usually referring to water in the saturated zone below the water table.
Internal Drainage Board (IDB)	A local public authority established in areas of special drainage need in England and Wales with permissive powers to manage water levels within their respective drainage districts. IDBs undertake works to reduce flood risk to people and property and manage water levels to meet local needs.
ISIS	A 1D hydraulic modelling software package.
Lead Local Flood Authority (LLFA)	As defined by the Flood and Water Management Act, in relation to an area in England, this means the unitary authority or where there is no unitary authority, the county council for the area. Milton Keynes Council is therefore the LLFA.
Light Detection and Ranging (LiDAR)	Airborne ground survey mapping technique, which uses a laser to measure the distance between the aircraft and the ground.
Local Planning Authority (LPA)	Body that is responsible for controlling planning and development through the planning system.
Main River	Watercourse defined on a 'main river map' designated by Defra. The Environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for main rivers. However overall responsibility for maintenance lies with the riparian owner.
Mitigation measure	An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere.
Ordinary watercourse	A watercourse that does not form part of a main river. This includes "all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows" according to the Land Drainage Act 1991.
Residual Flood Risk	The remaining flood risk after risk reduction measures have been taken into account.
Return Period	The average time period between rainfall or flood events with the same intensity and effect.
Risk	Risk is a factor of the probability or likelihood of an event occurring multiplied by consequence: Risk = Probability x Consequence. It is also referred to in this report in a more general sense.
SuDS Approving Body (SAB)	Statutory body responsible for the approval of Sustainable Drainage System (SuDS) systems in new planning applications, when enacted under the Flood and Water Management Act 2010.
Sequential Test	Aims to steer vulnerable development to areas of lowest flood risk.
Sewer Flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
Source Protection Zone (SPZ)	Defined areas in which certain types of development are restricted to ensure that groundwater sources remain free from contaminants.
Surface Water	Flooding caused when intense rainfall exceeds the capacity of the drainage systems or when, during prolonged periods of wet weather, the soil is so saturated such that it cannot accept any more water.
Sustainable drainage systems (SuDS)	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Topographic survey	A survey of ground levels and existing surface features.
TUFLOW	A modelling software package for simulating depth averaged 2D free-surface flows and is in widespread use in the UK and elsewhere for 2D flood inundation modelling.

1 INTRODUCTION

1.1 Terms of Reference

1.1.1 URS Infrastructure and Environment UK Ltd (URS) was commissioned by Milton Keynes Council (MKC) in May 2014 to review and revise the Level 1 Strategic Flood Risk Assessment (SFRA) for the Milton Keynes administrative area.

1.2 Project Aims

1.2.1 The National Planning Policy Framework[1] (NPPF) and associated National Planning Practice Guidance for Flood Risk and Coastal Change[2] emphasise the active role Local Planning Authorities (LPAs) such as MKC should take to ensure that flood risk is understood and managed effectively and sustainably throughout all stages of the planning process.

1.2.2 The NPPF outlines that Local Plans should be supported by a Strategic Flood Risk Assessment (SFRA) and LPAs should use the findings to inform strategic land use planning.

1.2.3 Figure 1-1 overleaf, reproduced from the Planning Practice Guidance, illustrates how flood risk should be taken into account in the preparation of the Local Plan for MKC.

1.2.4 A Level 1 SFRA for Milton Keynes Borough was produced by Halcrow Ltd in 2008[3]. Since this release, there have been a number of changes in legislation and guidance relating to planning and flood risk. .

1.2.5 The Flood and Water Management Act (FWMA) was issued in 2010, with the intention of enabling the provision of more effective flood management following the flooding of July 2007 and the recommendations of the Pitt Review. As such, MKC are designated a Lead Local Flood Authority (LLFA) and have significant duties and powers in relation to flooding from local sources, specifically surface water, groundwater and ordinary watercourses.

1.2.6 As well as legislative and planning policy changes, a number of new and revised datasets have been made available since the release of the existing Level 1 SFRA. Environment Agency flood risk mapping of main rivers has been revised for the Upper Great Ouse catchment, updated national surface water flood risk mapping has also been released by the Environment Agency for use by LPAs in SFRAs and broad scale mapping of susceptibility to groundwater flooding which has been purchased from the British Geological Survey (BGS).

1.2.7 The purpose of the updated Level 1 SFRA is to collate and analyse the most up to date flood risk information for all sources to provide an overview of flood risk issues across the Borough of Milton Keynes. This will be used by MKC to inform the preparation of the Local Plan for Milton Keynes Borough (PlanMK) including the application of the Sequential Test. It is also intended that the revised Level 1 SFRA will also assist prudent decision-making on flood risk issues by Development Management Officers on a day-to-day basis.

[1] Department for Communities and Local Government. 2012. *National Planning Policy Framework*. Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2
[2] Department for Communities and Local Government. 2014. *Planning Practice Guidance: Flood Risk and Coastal Change*. Available at: http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/
[3] Halcrow Group Ltd, July 2008. Milton Keynes Council Strategic Flood Risk Assessment for Local Development Framework. Level 1.

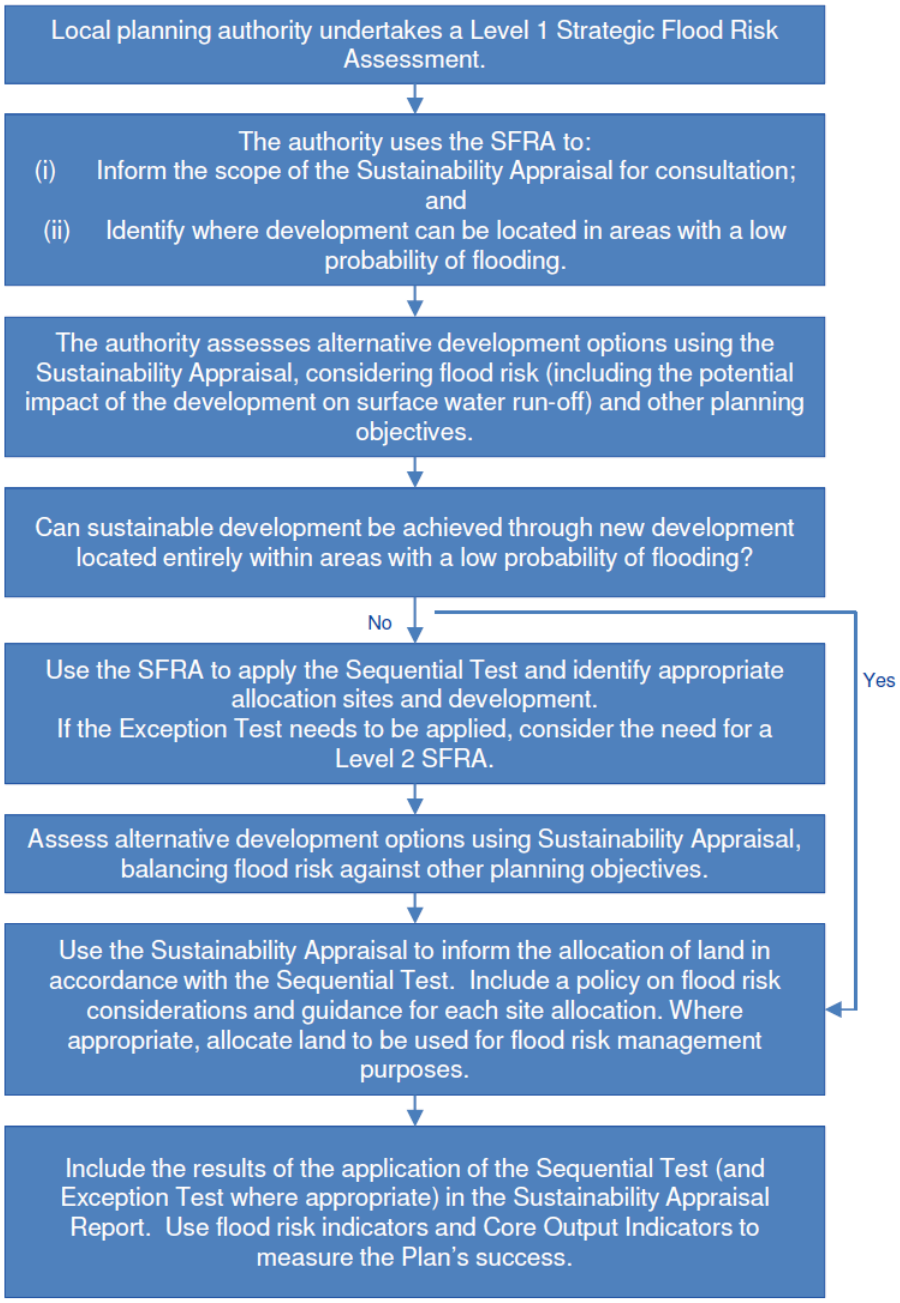

Figure 1-1 Taking flood risk into account in the preparation of a Local Plan (NPPG, p6)

1.3 Project Deliverables

1.3.1 The MKC updated Level 1 SFRA comprises a Main Technical Report with 4 supporting Appendices, as follows:

- Section 2: Planning Context
- Section 3: Study Methodology
- Section 4: Flood Risk in Milton Keynes Borough
- Section 5: Flood Risk Management Policy Considerations
- Section 6: Guidance on application of Sequential and Exception Tests
- Section 7: Guidance for preparing Site-Specific FRAs
- Section 8: Guidance on the application of SuDS
- Section 8: Summary and Recommendations
- Appendix A: Data Register
- Appendix B: Study Area Scale Mapping
- Appendix C: Fluvial Flood Zone Mapping
- Appendix D: Surface Water Flood Risk Mapping

1.4 Partner Organisations

1.4.1 There are several organisations involved in development and flood risk management in Milton Keynes Borough which are described in following paragraphs.

1.4.2 **Milton Keynes Council** (**MKC**) is the Local Planning Authority for the Borough, responsible for long term strategic planning of future development in the Borough of Milton Keynes in the Local Plan as well as for determining planning applications within the Borough. Under the Flood and Water Management Act (FWMA), MKC is also the Lead Local Flood Authority (LLFA) for the area, and has a duty to take the lead on the management of local flood risk, which includes flood risk from surface water, groundwater and ordinary watercourses.

1.4.3 **The Homes and Communities Agency (HCA)** is the non-departmental public body that funds new affordable housing in England. In 2012 the government agreed the transfer of land, assets and responsibilities from the HCA, and functions of the former Milton Keynes Partnership (a committee of the HCA) to MKC to create a streamlined planning and investment service.

1.4.4 **Environment Agency** has a strategic overview role for flood risk management associated with main rivers in Milton Keynes Borough (Great Ouse, Ouzel, Water Eaton Brook, Tongwell Brook and River Tove) and should be consulted on site specific Flood Risk Assessments for sites within the floodplain of these watercourses. The Environment Agency is continually improving and updating their Flood Map for Planning (Rivers and Sea) which is used to inform planning decisions, and has permissive powers to carry out flood defence works, maintenance and operational activities for these main rivers. However, overall responsibility for maintenance lies with the riparian owner.

1.4.5 **Bedford Group of Drainage Boards** is a consortium of statutory bodies providing local storm water management by undertaking watercourse maintenance and improvement, adoption and maintenance of SuDS and provision of advice and direction to local authorities and developers as part of local planning procedures. The Consortium comprises the Buckingham and River Ouzel Internal Drainage Board (IDB) which is of relevance to the Milton Keynes Borough, as well as the Bedfordshire and River Ivel IDB and the Alconbury and Ellington IDB. IDBs have

permissive powers to manage water levels within their district and undertake works to reduce flood risk to people and property. The IDB can provide advice on areas liable to flooding (non-main river); site specific Flood Risk Assessments (FRAs) in their area; and maintenance and adoption of surface water drainage facilities. However, overall responsibility for maintenance lies with the riparian owner. The area covered by the Bedford Group of Drainage Boards in Milton Keynes Borough is shown in Appendix B Figure B2.

1.4.6 **Milton Keynes Parks Trust (MKPT):** The river corridors form an important amenity for Milton Keynes and are included in the parkland which is leased by the MKPT. MKPT, a charitable trust, has the rights and responsibilities of riparian owners and is charged with the care of the parkland. The MKPT manages some balancing lakes within the linear parks.

1.4.7 **Canal and River Trust** is a charitable organisation with the responsibility for the maintenance and operation of canals in Milton Keynes.

1.4.8 **Anglian Water Services Limited (AWS)** has a duty as a statutory body to provide clean and waste water services to Milton Keynes. AWS is also responsible for the management, maintenance and operation of flood control structures at the network of balancing lakes and storm water sewers in Milton Keynes.

1.5 Milton Keynes Study Area

1.5.1 Milton Keynes Borough is located between London and Birmingham, in the Oxford Cambridge arc. The local authority region of Milton Keynes is bordered by Aylesbury Vale to the south, South Northamptonshire to the west, Wellingborough and Bedford to the north east and Central Bedfordshire to the east.

1.5.2 The City of Milton Keynes has grown from a collection of small towns and villages into a significant regional centre in less than 40 years. It is regarded as the largest and most successful British New Town of the 20th Century. It is located in one of the fastest growing sub-regions in Europe and remains a key focus for growth. Outside the city, the surrounding rural area has attractive countryside with a range of villages and small towns, which provide contrast to the new city. The scale and pace of development is unique in the UK, with around 2,500 to 3,000 new residents welcomed each year. Since it was designated a New Town in 1967, the population of the Milton Keynes Borough has grown from 60,000 to over 240,000[4] and the city's population is approaching the level anticipated in the original Master Plan (March,1970).

Topography

1.5.3 Appendix B Figure B1 shows the topography of the study area. Milton Keynes Borough is characterised by gently rolling hills in areas covered by boulder clay, but there are steeper slopes and higher elevations towards the outcrop of Woburn Sands and Bow Brickhill. The central part of the Borough along the floodplain of the main watercourses is low lying at levels of approximately 45 – 60m above Ordnance Datum (AOD). The land rises towards the built up part of Milton Keynes, located at approximately 100mAOD, as well as the north eastern and north western parts of the Borough towards Hardmead and Hanslope. It should be noted that there are some areas in the north of the Borough which are not covered

Principal Watercourses

1.5.4 There are five designated main rivers in the study area, the approximate locations of which are shown in Appendix B Figure B2. Main rivers are watercourses shown on the statutory main river maps held by the Environment Agency and the Department for Environment, Flood and Rural Affairs (DEFRA). The Environment Agency has permissive powers to carry out works

[4] Office of National Statistics, 2011 Census

necessary for flood defence purposes on these rivers. The overall responsibility for maintenance however, lies with the riparian owner. The main rivers within the Borough are described in the following paragraphs.

- The **River Great Ouse** rises near Brackley in Northamptonshire and drains the vale which separates the Cotswolds and the Chiltern Hills. The catchment area of the River Great Ouse is largely agricultural, with Newport Pagnell and Milton Keynes being the main urban areas. Within the study area, the River Great Ouse flows in a northwest direction along the northern boundary of Milton Keynes. It is joined by the River Tove at Wolverton and the River Ouzel at Newport Pagnell.
- The **River Ouzel** flows north through the eastern side of Milton Keynes until its confluence with the Great Ouse at Newport Pagnell. As with the River Great Ouse, the catchment of the Ouzel is largely rural. Leighton Buzzard and Milton Keynes are the main urban areas within its catchment.
- **Water Eaton Brook** is a tributary of the River Ouzel in Water Eaton in the south of Milton Keynes.
- **Tongwell Brook** is a tributary of the River Ouzel which flows from Tongwell, south of the M1 to the eastern side of Newport Pagnell.
- **River Tove** is a tributary of the Great Ouse which rises in Northamptonshire and flows for about 15 miles north and east of the town of Towcester before joining the Great Ouse between Cosgrove and Milton Keynes.

1.5.5 In addition to the designated main rivers there are several principal ordinary watercourses in Milton Keynes.

- **Loughton Brook** flows northeast from the Salden area towards Tattenhoe Park and then parallel to the A421 before flowing northwest parallel to the A5. The confluence of the Loughton Brook with the Great Ouse is at New Bradwell. The Loughton Brook catchment is almost entirely within the Designated Area (DA) of Milton Keynes. Loughton Brook , downstream of Fulmer Street is in a Drainage District and the IDB exercise its permissive powers to carry out works for flood defence purposes, Upstream of Fulmer Street the watercourse is under the jurisdiction of MKC. The Parks Trust manage the public open space and manage watercourses in the linear parks..
- **Broughton Brook** is a tributary of the River Ouzel on the eastern side of Milton Keynes, and is within the IDB area.
- **Calverton Brook** is a tributary of the Great Ouse which flows through the village of Lower Weald on the western side of Milton Keynes within the IDB area.
- **Caldecotte Brook** is a tributary of the River Ouzel. It flows west from Woburn Sands through the east side of Milton Keynes into Caldecotte Lake and is within the IDB area.
- **Chicheley Brook** drains the area surrounding the village of Chicheley in the east of the Borough, and flows west to join the Great Ouse immediately to the north of Newport Pagnell. It is under the jurisdiction of MKC.
- **Springhill Brook** flows east through Neath Hill in the northern part of Milton Keynes town. It then becomes culverted for approximately 1.5km before joining the Tongwell Brook adjacent to Tongwell Lake. It is under the jurisdiction of MKC.

Geology / Hydrogeology

1.5.6 Appendix B Figures B3 and B4 illustrate the superficial and bedrock geology across the Borough. The source of the data is sheets 220 and 203 from the BGS 1:50,000 Series. The bedrock geology of the Milton Keynes Borough comprises broadly from the Lower Jurassic Lias Group to the outcrop of the Woburn Sands Formation from the Lower Cretaceous.

1.5.7 The bedrock in the south of the Borough, underlying the main urban area consists mostly of mudstone from the Oxford Clay Formation, with sand and mudstone of the Kellaways Formation in the north-east of the Borough. In the far south-eastern corner of the Borough there is an outcrop of the Woburn Sands Formation (part of the Lower Greensand Formation).

1.5.8 In the north of the Borough, the underlying geology consists of Great Oolite Group (comprising Sandstone, Limestone and Agrillaceous rocks) and the Blisworth Limestone Formation. Towards the north-west is the Lias Group comprising of Mudstone, Siltstone and Ironstone.

1.5.9 The superficial geology of the area consists of Glacial Till and shows River Terrace Deposits, Alluvium and Head along the corridors of the watercourses namely the rivers Ouzel and the River Great Ouse and their tributaries.

1.5.10 Table 1-1 presents the various geological units that are found within the study area in stratigraphic order.

Table 1-1 Geological Units in the Study Area

Geological Unit		Rock Type	Thickness (metres)
Superficial Deposit	Alluvium	Clay, Silt, Sand and Gravel	-
	River Terrace Deposits	Sand and Gravel	-
	Head	Gravel, Sand and Clay	-
	Glacial Sand and Gravel	Sand and Gravel	-
	Till	Gravel, Sand, Clay & Silt	-
Bedrock Geology	Gault Formation	Mudstone	70-75
	Woburn Sands Formation	Sand and Sandstone	0-120
	Kimmeridge Clay Formation	Mudstone and thin Limestone	Up to 30
	Oxford Clay Formation	Mudstone	c.70
	Kellaways Formation	Sand and Mudstone	Up to 5
	Great Oolite Group	Limestone, Mudstone and Clay	c. 23
	Cornbrash Formation	Limestone	1 to 2
	Blisworth Clay Formation	Mottled Mudstone	c.1
	Blisworth Limestone Formation	Limestone	c.11
	Rutland Formation	Mudstone	2-4
	Whitby Mudstone Formation	Mudstone	up to 120
	Lias Group	Mudstone, Ironstone and thin Limestone beds	Up to 76

2 LEGISLATIVE AND PLANNING POLICY CONTEXT

2.1 Introduction

2.1.1 This Section provides an overview of the legislative and national, regional and local planning policy context specific to the Level 1 SFRA for Milton Keynes.

2.2 Flood and Water Management Act

2.2.1 In response to the severe flooding across large parts of England and Wales in summer 2007, the Government commissioned Sir Michael Pitt to undertake a review of flood risk management. The Pitt Review – Learning Lessons from the 2007 Floods[5] and subsequent progress reviews outlined the need for changes in the way the UK is adapting to the increased risk of flooding and the role different organisations have to deliver this function.

2.2.2 The Flood and Water Management Act 2010 (The Act)[6], enacted by Government in response to The Pitt Review, designated unitary authorities, including MKC, as Lead Local Flood Authority (LLFA). As LLFA, MKC has responsibilities to lead and co-ordinate local flood risk management. Local flood risk is defined as the risk of flooding from surface water runoff, groundwater and small ditches and watercourses (collectively known as ordinary watercourses).

2.2.3 The Act also formalises the flood risk management roles and responsibilities for other organisations including the Environment Agency, water companies and highways authorities. The responsibility to lead and co-ordinate the management of tidal and fluvial flood risk remains that of the Environment Agency.

National Strategy for Flood and Coastal Erosion Risk Management

2.2.4 In accordance with the Act, the Environment Agency has developed a National Strategy for Flood and Coastal Erosion Risk Management (FCERM) in England[7]. This Strategy provides a framework for the work of all flood and coastal erosion risk management authorities.

2.2.5 The National FCERM Strategy sets out the long-term objectives for managing flood and coastal erosion risks and the measures proposed to achieve them. It sets the context for, and informs the production of local flood risk management strategies by LLFAs, which will in turn provide the framework to deliver local improvements needed to help communities manage local flood risk. It also aims to encourage more effective risk management by enabling people, communities, business and the public sector to work together to:

- ensure a clear understanding of the risks of flooding and coastal erosion, nationally and locally, so that investment in risk management can be prioritised more effectively;
- set out clear and consistent plans for risk management so that communities and businesses can make informed decisions about the management of the remaining risks;
- encourage innovative management of risks taking account of the needs of communities and the environment;
- ensure that emergency responses to flood incidents are effective and that communities are able to respond properly to flood warnings; and,
- ensure informed decisions are made on land use planning.

[5] Cabinet Office (2008) Sir Michael Pitt Report 'Learning lessons learned from the 2007 floods' http://www.environment-agency.gov.uk/research/library/publications/33889.aspx
[6] HMSO (2010) The Flood and Water Management Act 2010 http://www.legislation.gov.uk/ukpga/2010/29/contents
[7] Defra, Environment Agency (2011) The National Flood and Coastal Erosion Risk Management Strategy for England.

2.2.6 The Environment Agency's 'Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities'[8] guidance is a supporting note for the National FCERM Strategy. It provides the UK Climate Projections (UKCP09) climate change factors for river flood flows and extreme rainfall for each river basin district, and provides advice on applying climate change projections in the FCERM. It is essential that land use planning decisions consider the impact of a changing climate where appropriate.

Milton Keynes Local Flood Risk Management Strategy

2.2.7 As a LLFA, MKC has a statutory duty to develop, maintain, apply and monitor a strategy for local flood risk management. MKC are currently in the process of preparing their Local Flood Risk Management Strategy (LFRMS) and should use this Level 1 SFRA update as a vital source of baseline information.

2.3 Flood Risk Regulations

2.3.1 As well as the duties under the Act to prepare a LFRMS, MKC have legal obligations under the EU Floods Directive[9], which was transposed into UK Law through the Flood Risk Regulations 2009[10] ('the Regulations').

Preliminary Flood Risk Assessment

2.3.2 Under the Regulations, all LLFAs were required to prepare a Preliminary Flood Risk Assessment (PFRA) report. This is a high level screening exercise to identify areas of significant risk as Indicative Flood Risk Areas across England where 30,000 people or more are at risk from flooding for reporting to Europe. Accordingly, there are no Indicative Flood Risk Areas within the Milton Keynes Borough.

2.3.3 The Bedford Group of Drainage Boards prepared a joint PFRA[11] on behalf of Central Bedfordshire Council, Bedford Borough Council and MKC. The PFRA seeks to provide a high level overview of flood risk from local flood sources and includes flooding from surface water (i.e. rainfall resulting in overland runoff), groundwater, ordinary watercourses (smaller watercourses and ditches) and canals. It excludes flood risk from main rivers, the sea and reservoirs, as these are assessed nationally by the Environment Agency.

2.3.4 The PFRA report looks at past flooding and where future flooding might occur across the area and the consequences it might have to people, properties and the environment. The report will help MKC to develop their LFRMS.

2.4 Anglian River Basin District draft Flood Risk Management Plan

2.4.1 Under the European Union (EU) Floods Directive and UK Flood Risk Regulations, LLFAs must prepare Flood Risk Management Plans (FRMPs) in formally identified Flood Risk Areas[12] where the risk of flooding from local sources is significant (i.e. surface water, groundwater, ordinary watercourses), and the Environment Agency is required to prepare FRMPs for all of England covering flooding from main rivers, the sea and reservoirs.

[8] Environment Agency (2010) Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities
[9] European Union (2007) EU Floods Directive http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32007L0060:EN:NOT
[10] HSMO (2009) The Flood Risk Regulations http://www.legislation.gov.uk/uksi/2009/3042/contents/made
[11] Bedford Group of Drainage Boards, July 2011, Upper River Great Ouse Tri LLFA Preliminary Flood Risk Assessment for Bedford Borough Council, Central Bedfordshire Council and Milton Keynes Council http://m.centralbedfordshire.gov.uk/environment/natural-environment/flood-risk/default.asp
[12] Flood Risk Areas were identified through the Preliminary Flood Risk Assessment (PFRA) This identified where the risk of flooding from local flood risks is significant, http://webarchive.nationalarchives.gov.uk/20130402151656/http://archive.defra.gov.uk/environment/flooding/documents/interim2/flood-risk-method.pdf

2.4.2 As such, the Anglian River Basin District FRMP[13] which has been published for consultation by the Environment Agency and sets out the proposed measures to manage flood risk in the Anglian River Basin District from 2015 to 2021 and beyond. This document draws on existing reports and plans which have been prepared in the past.

2.5 National Planning Policy Framework

2.5.1 The NPPF consists of a framework within which councils and local people can produce local and neighbourhood plans that reflect the needs and priorities of their communities. The overall approach of the NPPF to flood risk is broadly summarised Paragraph 103:

2.5.2 "When determining planning applications, LPAs should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific FRA following the Sequential Test, and if required the Exception Test, it can be demonstrated that:

- within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location, and
- development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of sustainable drainage systems."

2.5.3 Further detail regarding the Sequential and Exception Tests is included in Section 6.

2.6 Local Planning Policy

2.6.1 The Local Plan for Milton Keynes was adopted in December 2005 and sets out how the Borough will be developed up until 2011. This Local Plan will be replaced by the updated Local Plan (Plan MK) which is currently being prepared and expected to be adopted in 2017; for which this Level 1 SFRA has been produced.

2.6.2 The Milton Keynes Core Strategy, adopted by MKC in July 2013 under Regulation 6 of the Town and Country Planning (Local Planning) (England) Regulations 2012, provides strategic planning policy for the Borough up to the year 2026. The Core Strategy guides future development of the Borough and includes a new strategic land allocation for around 2,900 homes in the south east of the city.

2.6.3 The Core Strategy contains strategic policies which replace those in the 2005 Local Plan. Most of the remaining 2005 Local Plan policies are currently saved until the adoption of the new local plan, Plan:MK. Plan:MK will also review and replace the Core Strategy once adopted. Policy CS1 of the Core Strategy identifies the current development strategy for Milton Keynes as follows:

2.6.4 "The majority of new development will be focused on, and adjacent to, the existing urban area of Milton Keynes including:

- Continued development of the City of Milton Keynes;
- Completion of existing city estates, such as Tattenhoe Park, Oakgrove, Oxley Park and Kingsmead South, as well as some smaller sites within other estates including Grange Farm and Monkston Park;
- Existing Local Plan Expansion Areas to the north, east and west of Milton Keynes, Stantonbury Park Farm and Newton Leys; and
- Redevelopment and infill development (particularly in the older parts of the city).

[13] Environment Agency (October 2014) Anglian River Basin District Consultation on the draft Flood Risk Management Plan https://consult.environment-agency.gov.uk/portal/ho/flood/draft_frmp/consult?pointId=3063510

2.6.5 A Strategic Land Allocation (SLA) to the south east of the city will provide a sustainable urban extension adjoining the existing urban boundary.

2.6.6 In addition other non-strategic development sites will be brought forward through the Site Allocations Plan to provide short term flexibility and contingency ahead of a full review of the Core Strategy in Plan:MK.

2.6.7 In the remainder of the Borough:

- Development will be concentrated on the Key Settlements of Newport Pagnell, Olney and Woburn Sands, as the towns with the largest range of facilities and best public transport links;
- A limited amount of new housing will be allowed in Sherington (as a Selected Village); and,
- Small scale redevelopment and infill development will be permitted in the 'Other Villages' with a development boundary including Astwood, Castlethorpe, Clifton Reynes, Emberton, Lavendon, Little Brickhill, Long Street, New Haversham, Newton Blossomville, North Crawley, Ravenstone, Sherington, Stoke Goldington, Wavendon and Weston Underwood".

Development and Flood Risk Supplementary Planning Guidance (SPG)

2.6.8 The Development and Flood Risk SPG was adopted in May 2010 and provides general guidance on development and flood risk within Milton Keynes. It aims to guide developers on the following aspects related to drainage and flood risk throughout the Milton Keynes Borough:

- Fluvial flood zones and risks and the constraints imposed upon development;
- What strategic measures are required to facilitate further development and how these measures may occur in conjunction with localised measures such as SuDS; and,
- Considerations relating to conservation and amenity, funding and securing reliable, long-term maintenance.

2.6.9 The SPG promotes the utilisation of sustainable drainage where applicable and highlights how they can be used to overcome issues associated with conventional drainage systems. It demonstrates how SuDS can be used throughout the borough of Milton Keynes, alongside other surface water management infrastructure such as balancing lakes to develop blue infrastructure which derives multiple benefits relating to amenity, nature conservation, water quality etc.

2.6.10 The Milton Keynes' Drainage SPG is to be reviewed in 2015 in order to reflect changes to national planning policy.

2.7 IDB Policy

2.7.1 Internal Drainage Boards' (IDB) main responsibilities are to manage water levels in the watercourses designated to each IDB and work in partnership with other authorities to actively manage and reduce the risk of flooding within the board's district. IDBs are normally formed by members elected from agricultural ratepayers by Special Levy paying Local Authorities. They have permissive powers under the Land Drainage Act 1991 (as amended by the 1994 Act) to undertake maintenance on any watercourse within their district other than "main river" (known as 'ordinary watercourses') and to supervise all matters relating to the drainage of land within their districts. Permissive powers means that the IDBs are permitted to undertake works on ordinary watercourses but the responsibility remains with the riparian owner[14] as the IDBs

[14] The responsibility for managing and maintaining ordinary watercourses falls to riparian owners who typically own land on either bank and therefore are deemed to own the land to the centre of the watercourse. Bedford Borough Council, as the LLFA, has responsibility to manage the risk of flooding arising from the watercourses through engagement with riparian owners and enforcing maintenance responsibilities in accordance with the Land Drainage Act 1991, http://www.legislation.gov.uk/ukpga/1991/59/contents.

are not obligated. IDBs can undertake works on watercourses outside their drainage district in order to benefit the district. IDBs may make byelaws, approved by the relevant Minister, for securing the efficient working of the drainage systems.

2.7.2 The Bedford Group of Drainage Boards is a consortium comprising the Buckingham and River Ouzel IDB which is of relevance to Milton Keynes, as well as the Bedfordshire and River Ivel IDB and the Alconbury and Ellington IDB.

Buckingham and River Ouzel IDB Byelaws (2002):

- Byelaw 3 - No person shall, without the previous consent of the Board, by means of any channel syphon pipeline or sluice or by any other means whatsoever, introduce any water into the district or, whether directly or indirectly, increase the flow of volume of water in any watercourse in the District.
- Byelaw 4 – Any person having control of any sluice, water control structure or appliance for introducing water into any watercourse in the District or for controlling or regulating or affecting the flow of water in, into or out of any watercourse shall use and maintain such sluice, water control structure or appliance in accordance with such reasonable directions as may from time to time be given by the Board with a view to the prevention of flooding or any shortage in the flow or supply of water and to the efficient working of the drainage system in the District.
- Byelaw 6 – No person shall, without the previous consent of the Board, take any action, or knowingly permit or aid or abet any person to take any action to stop up any watercourse or divert or impede or alter the level of or direction of the flow of water in, into or out of any watercourse.
- Byelaw 10 - No person without the previous consent of the Board shall erect any building or structure, whether temporary or permanent, or plant any tree, shrub, willow or other similar growth within 9 metres of the landward toe of the bank where there is an embankment or wall or within 9 metres of the top of the batter where there is no embankment or wall, or where the watercourse is enclosed within 9 metres of the enclosing structure.
- Byelaw 15 - No person shall use or cause or permit to be used any bank of any watercourse for the purpose of depositing or stacking or storing or keeping any rubbish or goods of any material or things thereon in such a manner as by reason of the weight, volume or nature of such rubbish, goods, material or things causes or is likely to cause damage to or endanger the stability of the bank or channel of the watercourse or interfere with the operations or access of the Board or the right of the Board to deposit soil on the bank of the watercourse.
- Byelaw 16 - No person shall without the previous consent of the Board dredge or raise or take or cause or permit to be dredged or raised or taken any gravel, sand, ballast, clay or other material from the bed or bank of any watercourse.
- Byelaw 17 - No person shall without the previous consent of the Board:-
    - (a) place or affix or cause or permit to be placed or affixed any gas or water main or any pipe or appliance whatsoever or any electrical main or cable or wire in or over any watercourse or in, over or through any bank of any watercourse;;
    - (b) cut, pare, damage or remove or cause or permit to be cut, pared, damaged or removed any turf forming part of any bank of any watercourse, or dig for or remove or cause or permit to be dug for or removed any stone, gravel, clay, earth, timber or other material whatsoever forming part of any bank of any watercourse or do or cause or permit to be done anything in, to or upon such bank or any land adjoining such bank of such a nature as to cause damage to or endanger the stability of the bank;

- (c) make or cut or cause or permit to be made or cut any excavation or any tunnel or any drain, culvert or other passage for water in, into or out of any watercourse or in or through any bank of any watercourse;
- (d) erect or construct or cause or permit to be erected or constructed any fence, post, pylon, wall, wharf, jetty, pier, quay, bridge, loading stage, piling, groyne, revetment or any other building or structure whatsoever in, over or across any watercourse or in or on any bank thereof;
- (e) place or fix or cause or permit to be placed or fixed any engine or mechanical contrivance whatsoever in, under or over any watercourse or in, over or on any bank of any watercourse in such a manner or for such length of time as to cause damage to the watercourse or banks thereof or obstruct the flow of water in, into or out of such watercourse.
- Provided that the foregoing provisions of this Byelaw shall not apply to temporary works constructed in an emergency, provided that notice thereof shall forthwith be given in writing to the Drainage Board and that the works are removed if so requested by, and in accordance with the requirements of the Drainage Board.

- Byelaw 18 - No person shall, in the flood plain of any watercourse, without the previous consent of the Board, construct, erect or form, or cause to be constructed, erected or formed, any structure or deposit or cause to be deposited any material or form, or cause to be formed any heap of materials, which is or are of such a size or nature or is or are placed in such a position or positions as to be likely to divert or obstruct the flow of water in the flood plain or reduce the effective flood storage volume of a flood plain to the detriment of any land upstream or downstream.
  - Provided that the foregoing provisions of this Byelaw shall not apply to any temporary works constructed in an emergency (where notice of the existence of such works has been given to the Board) or temporary siting of hay, straw stacks and such similar incidents that occur in the ordinary course of accepted agricultural practice, provided that the works are removed, if so required by and in accordance with the requirements of the Board.
  - Provided further that this clause is without prejudice to Byelaw 15 and shall not apply in circumstances where planning permission has been granted for such structures, deposits or works by the local planning authority.

3 STUDY METHODOLOGY

3.1 Level 1 SFRA Methodology

3.1.1 The Level 1 SFRA is a desk-based study, using readily available existing information and datasets to enable the application of the Sequential Test and to identify where the Exception Test may be required. The main tasks in preparing the Level 1 SFRA are described below.

Establishing relationships and understanding the planning context

3.1.2 An inception meeting was held to facilitate relationships between the project team, MKC, Bedford Group of Drainage Boards and the Environment Agency and to aid collaborative working and the free exchange of available information and datasets. MKC provided an overview of the current planning context with respect to the preparation of the Plan:MK Local Plan and main flood risk issues in the area were identified and discussed.

3.1.3 Discussions were also held with representatives of AWS, the Milton Keynes Parks Trust and the Canal and River Trust at the project start-up phase to enable information held by these organisations to be included in the SFRA.

Gathering data and analysing it for suitability

3.1.4 Under Section 10 of NPPF, the risk of flooding from all sources must be considered as part of a Level 1 SFRA, including flooding from rivers (fluvial), land (overland flow and surface water), groundwater, sewers and artificial sources. Flooding from the sea is not relevant to the borough of Milton Keynes.

3.1.5 In order to provide this assessment of all sources of flooding in Milton Keynes, an extensive set of datasets was obtained from the stakeholder organisations. This information was subject to a quality review and gap analysis by the project team to determine the best datasets for inclusion in the Level 1 SFRA update. Further details of the datasets are included in Section 4 and within the data register in Appendix A.

Producing strategic flood risk maps, GIS deliverables and a technical report

3.1.6 A series of GIS maps were produced using the data gathered during the initial part of the study. The mapping deliverables are identified in Table 3-1.

Table 3-1 Strategic Flood Risk Maps

Appendix	Figures
Appendix B: Area wide mapping (Scale 1:95,000)	Topography Watercourses, Water bodies, Canals, Flood Storage Area and Flood Defences Superficial Geology, Bedrock Geology Internal and External Sewer Flooding Records Susceptibility to Groundwater Flooding BGS Infiltration SuDS Suitability Mapping Environment Agency Flood Warning Areas
Appendix C: Fluvial Flood Zone Mapping (Scale 1:25,000)	Figures C1-C9 Fluvial Flood Zone Mapping for the whole study area at 1:25,000 scale.
Appendix D: Surface Water Flood Risk Mapping (Scale 1:25,000)	Figures D1-D9 Surface Water Flood Risk Mapping for the whole study area at 1:25,000 scale.

Providing suitable guidance

3.1.7 Sections of this report provide specific guidance for MKC on policy considerations, the application of the Sequential Test, guidance on the preparation of site-specific FRAs and guidance of the application of SuDS in the borough of Milton Keynes.

3.2 Need for a Level 2 SFRA

3.2.1 Following the application of the Sequential Test by MKC, there may be insufficient number of suitably available sites for development within areas identified to be at low risk of flooding and it may become necessary to consider the application of the Exception Test. Where this is necessary, the scope of the SFRA may need to be widened to a Level 2 assessment.

3.2.2 The increased scope Level 2 SFRA will need to consider the detailed nature of the characteristics within a Flood Zone including flood probability, flood depth, flood velocity, rate of onset of flooding and the duration of flooding. This may require interrogation of 2D modelling and breach / overtopping analysis for certain locations.

3.2.3 The scope of a Level 2 SFRA cannot fully be determined until the Sequential Test has been undertaken by MKC on all possible site allocations.

4 FLOOD RISK IN MILTON KEYNES

4.1 Introduction

4.1.1 This Section provides the strategic assessment of the flood risk across the borough of Milton Keynes from each of the sources of flooding outlined in the NPPF. For each source of flooding, the datasets used for the assessment are described, details of any historical incidents are provided, and where appropriate, the impact of climate change on the source of flooding is described. This Section should be read in conjunction with the mapping in Appendices B, C and D.

4.2 Flooding from Rivers

4.2.1 The Environment Agency 'Detailed River Network' dataset has been used to identify watercourses in the study area and their designation (i.e. main river or ordinary watercourse). There are five main rivers present and numerous ordinary watercourses within the Milton Keynes administrative area, as described in Section 1.7, the approximate location of which are shown in Appendix B Figure B2. More detailed mapping is provided in Appendix C, Figures C1-C9. Figure B2 also shows the extent of the district of the Bedford Group of Drainage Boards and the arterial watercourses on which the Boards have powers to undertake works.

Historic Records of River Flooding

4.2.2 Prior to the development of Milton Keynes new town there was regular flooding from the River Great Ouse, River Ouzel and Loughton Brook. During the floods of 1947 and 1968 a number of areas around Bletchley, Newport Pagnell, Bradwell, Loughton and Simpson were seriously affected. However, Milton Keynes is unusual as the development of the new town has meant there have been significant changes to the catchment characteristics, with increased run off from urban areas mitigated by a system of public storm sewers, reengineered watercourses and balancing lakes. These changes in the system should be considered when applying information about the location of flooding prior to the development of Milton Keynes to the present day. For instance, the Milton Keynes Drainage Study (Halcrow 2000) found that water levels for a 1 in 100 year storm at Newport Pagnell would be lower than they were prior to the development of Milton Keynes, due to storage provided by the balancing lakes on the River Ouzel and by their role in reducing flood peak water levels. It should also be noted that the linear lakes are designed to flood occasionally to protect Milton Keynes; therefore they are not available as public open space.

4.2.3 Information on historical flooding was gathered during the preparation of the 2008 SFRA from Environment Agency flood outlines and measured flood levels, published reports and a review of the local newspaper. As part of the revised SFRA, historic records of fluvial flooding have been provided by the Bedford Group of Drainage Boards in point data format. The Environment Agency has also provided some point data as well as an extract from the 'Recorded Flood Outlines' and 'Historic Flood Map' datasets for the study area[15]. These datasets are presented in Figures C1-9; areas in Milton Keynes found to have a history of flooding include:

- Newport Pagnell, which flooded in Easter 1998 and March 1947 from the River Great Ouse and River Ouzel, and in September 1992 from the River Ouzel. The Environment Agency node measurements show several properties flooded in Lakes Lane, Newport Pagnell in the 1998 floods, and that in the 1992 floods there was flooding to Willen Lane, Nene Close, Dove Close, Trent Close, Riverside, Mill Street, and Northampton Rd. In addition, Silver Street, Tickford Street and Priory Street flooded due to the surface water drains surcharging in the 1992 floods.

[15] The 'Recorded Flood Outlines' dataset identifies the flood extents associated with specific flood events. The 'Historic Flood Map' shows greatest extent of past flooding and does not identify individual flood events.

- Stony Stratford, which is at risk of flooding from the River Great Ouse, flooded in March 1947 and 1998. The Stony Stratford re-feasibility study reports that part of the town was also flooded during the Easter 1998 event, and four non-residential buildings were inundated. Environment Agency measured levels show that flooding occurred to properties in Fegans Court, the High Street, Prospect Road, Temperance Terrace and Mill Lane. The non-residential buildings were in Queen Eleanor Street and it is thought that the flooding was due to surface water drainage problems. There was further flooding to Fegans Court and the High Street in January 2003. The local newspaper reports that in the July 2007 floods there was flooding to the High Street and Temperance Terrace.
- Bletchley is at risk of flooding from Water Eaton Brook. Parts of Water Eaton flooded in July 1968, due to the channel capacity being exceeded. The Water Eaton Brook Standard of Protection (SOP) Study reports that the 1968 event caused flooding to houses along the south front of Water Eaton Road, however, the lower part of Water Eaton Brook was canalised and straightened as a response to this flooding. Environment Agency historic flood levels show further flooding in 1998 on Water Eaton Road and Frensham Drive, but it is not clear if any properties were flooded. The local newspaper for August 2006 reports flooding to Water Eaton Road, but not to properties.
- Parts of Olney and Newton Blossomville are shown as having flooded in 1947 from the Great Ouse. However, the Olney, Newton Blossomvile and Turvey pre-feasibility study found no properties at risk of flooding in Newton Blossomville below a 1 in 100 year event and states that the properties in Newton Blossomville are located on high ground along the edge of the river valley and as such are outside the river flood plain. In Olney the study found the standard of protection to be as low as 1 in 5 years for some properties in Mill Close. Environment Agency measurements record that the grounds of 2 properties in Church Street, Olney were flooded in April 1998, and that there was flooding to a goods yard on Carey Way, Olney in March 1947.
- Fenny Stratford is within the March 1947 flood outline for the River Ouzel. There are no recorded flood levels. The River Ouzel at Milton Keynes SoP Study identified 5 properties at risk of flooding at a 1 in 2 year return period just downstream of Fenny Stratford including Belvedere Farm and nurseries, with further properties at risk on Powel Haven, Mill Lane, Woolstone, Wattling Street, Manor Field, and Watling Terrace from higher return periods.
- New Bradwell flooded in 1998 and 1947 from the River Great Ouse, and 1968 from Loughton Brook. The Environment Agency flood event outlines only show flooding to gardens and grounds, not buildings, for these events.
- Shenley Brook End, which flooded in August 1980 due to an obstruction or blockage of a culvert on Shenley Brook. The local newspaper reports flood damage to Long Meadow School but does not give a date.
- Walton Park. The local newspaper reports flooding to Wadesmill Lane, under the v10 road bridge in November 2004 and November 2007. It reports that a local resident claims that the street floods once or twice a year. The newspaper attributes the flooding to the brook next to the community centre.
- The newspaper reports flooding to Bourton Low in Walnut Tree due to blockage to a culvert on Caldecotte Brook.
- Two Mile Ash, where the newspaper reports flooding to a garden in Ellesborough Grove.
- Cosgrove, which flooded in Easter 1998 from the Great Ouse.
- Ravenstone, parts of which are in the Environment Agency flood outline for August 1980 which reports that the channel capacity on an ordinary watercourse was exceeded.
- Lavendon, parts of which are in the Environment Agency flood outline for August 1980 which reports that the channel capacity on an ordinary watercourse was exceeded.

- Stoke Goldington, where there were two severe flooding events on 4th June and the 2nd July 2007. Following these events MKC commissioned WSP to produce a report into the cause of the flooding and potential mitigation measures, the second stage of which was completed in January 2008. The study found that Stoke Goldington had a long history of flooding with previous events in the 1880s, 1968, 1973, 1980, 1984 and 2002. Hydraulic analysis showed that the flooding was due to a combination of surface run off from higher ground and insufficient capacity in open channels and culverts. There are recorded flood levels in Orchard Way, High Street, Maltings Close and Ram Alley.
- Tathall End, where Environment Agency point measurements record 150mm of flooding to a property in 1973. The local newspaper reports flooding to the road in July 2007.
- Woburn Sands, where the local newspaper reports flooding due to a blocked culvert in August 2004.
- Lower Weald, which flooded in Easter 1998 from Calverton Brook, due to insufficient culvert capacity.

Flood Zone Maps

4.2.4 The risk of flooding is a function of the probability that a flood will occur and the consequence to the community or receptor as a direct result of flooding. The NPPF seeks to assess the probability of flooding from rivers and sea by categorising areas within the fluvial floodplain into zones of low, medium and high probability, as defined in Table 4-1 and presented on the 'Flood Map for Planning (Rivers and Sea)' available on the Environment Agency website. These Flood Zones have also been presented in Figures B5 and C1 – C9.

Table 4-1 Fluvial Flood Zones (extracted from the NPPG, 2014)

Flood Zone	Fluvial Flood Zone Definition	Probability of Flooding
Flood Zone 1	Land having a less than 0.1% Annual Exceedance Probability (AEP) (1 in 1,000 chance of flooding in any given year). Shown as clear on the Flood Map – all land outside Flood Zones 2 and 3.	Low
Flood Zone 2	Land having between a 1% AEP (1 in 100 chance of flooding in any given year) and 0.1% (1 in 1,000 chance of flooding in any given year).	Medium
Flood Zone 3a	Land having a 1% AEP or greater (1 in 100 chance of flooding in any given year).	High
Flood Zone 3b	Land where water has to flow or be stored in times of flood, or land purposely designed to be flooded in an extreme flood event (0.1% AEP). The identification of the functional floodplain takes into account local circumstances but for the purposes of this SFRA, land modelled to flood during a 5% AEP event (1 in 20 chance of flooding in any given year) or greater in any year has been mapped, in agreement with the Environment Agency and Bedford Group of Internal Drainage Boards.	Functional Floodplain

Flood Map for Planning (Rivers and Sea)

4.2.5 The 'Flood Map for Planning (Rivers and the Sea)' provides information on the areas that would flood if there were no flood defences or buildings in the "natural" floodplain. The 'Flood

Map for Planning (Rivers and Sea)' dataset is available on the Environment Agency website[16] and is the main reference for planning purposes as it contains Flood Zones 1, 2 and 3a which are referred to in the NPPF and presented in Table 4-1.

4.2.6 The 'Flood Map for Planning (Rivers and Sea)' was first developed in 2004 using national generalised modelling (JFLOW). It is routinely updated and revised using the results from the Environment Agency's programme of catchment studies, entailing topographic surveys, hydrological and/or hydraulic modelling as well as previous flood events.

4.2.7 It should be noted that a separate map is available on the Environment Agency website which is referred to as 'Risk of Flooding from Rivers and Sea'[17]. This map takes into account the presence of flood defences and so describes the actual probability of flooding, rather than the probability if there were no defences present. While flood defences reduce the level of risk they do not completely remove it as they can be overtopped or fail for example in extreme weather conditions, or if they are in poor condition. As a result the maps may show areas behind defences to still have some risk of flooding. This mapping has been made available by the Environment Agency as the primary method of communicating flood risk to members of the public, however for planning purposes the 'Flood Map for Planning (Rivers and the Sea)' and associated Flood Zones remains the primary source of information.

Hydraulic Modelling Studies

4.2.8 Table 4-2 provides a summary of the hydraulic modelling studies that have been undertaken for the main rivers in the borough of Milton Keynes and used to inform the 'Flood Map for Planning (Rivers and Sea)'.

Table 4-2 Hydraulic models for main rivers in Milton Keynes

Watercourse	*Modelling Study*
Upper River Great Ouse	Capita Symonds Scott Wilson, Environment Agency Anglian Region (June 2011) Upper River Great Ouse Flood Hazard Mapping Study. Coverage: River Great Ouse from Brackley to Newport Pagnell, River Ouzel, River Tove, Loughton Brook, Water Eaton Brook. Hydraulic modelling has been undertaken at broadscale and more detailed level; three broadscale models were constructed to represent the smaller tributaries in the upper reaches of the Upper Ouse catchment and a detailed model has been constructed for the remaining reaches of river network including locations where hazard mapping is required.
Middle Great Ouse	Halcrow, Environment Agency (December 2011) Middle Great Ouse Flood Mapping Study. Coverage: Tyringham in Newport Pagnell to Roxton (north east of Bedford). A series of 1D, 2D and 1D-2D models and model groups were constructed using ISIS TUFLOW software making best use of available data to provide consistent coverage for the Middle Great Ouse and all contributing catchments of greater than 3km.

4.2.9 It should be noted that the scope of these modelling studies typically covers flooding associated with main rivers, and therefore ordinary watercourses that form tributaries to the main rivers may not always be included in the model. Modelling of ordinary watercourses

[16] Environment Agency Flood Map for Planning (Rivers and Sea) http://apps.environment-agency.gov.uk/wiyby/37837.aspx
[17] Environment Agency 'Risk of Flooding from Rivers and Sea' http://watermaps.environment-agency.gov.uk/wiyby/wiyby.aspx?topic=floodmap#x=237038&y=161974&scale=1

available on the 'Flood Map for Planning (Rivers and Sea)' may be the result of the national generalised JFLOW modelling carried out by the Environment Agency and may need to be refined when determining the probability of flooding for an individual site and preparing a site-specific FRA. Further detail is provided in Section 7.2.

Functional Floodplain (Flood Zone 3b)

4.2.10 The Functional Floodplain is defined in the NPPF as 'land where water has to flow or be stored in times of flood'. The Functional Floodplain (also referred to as 'Flood Zone 3b'), is not separately distinguished from Flood Zone 3a on the Flood Map for Planning. The extent of the Functional Floodplain should be identified by the LPAs within the SFRA in discussion with the Environment Agency and LLFA.

4.2.11 The NPPG states that the identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. However, land which would naturally flood during a 5% AEP or greater in any year, or is designed to flood (such as a flood attenuation scheme) in an extreme (0.1% AEP) flood, should provide a starting point for consideration and discussions to identify the functional floodplain. Further to this, the NPPG does not provide any additional guidance on how to define the functional floodplain.

4.2.12 The PPG states that *'areas which would naturally flood, but which are prevented from doing so by existing defences and infrastructure or solid buildings, will not normally be defined as functional floodplain'*. There may be opportunities to reinstate areas which can operate as functional floodplain through the use of previously developed land adjacent to watercourses to provide space for flood water to reduce the risk to new and existing development.

4.2.13 The NPPG recognises the importance of pragmatic planning solutions that will not unnecessarily 'blight' areas of existing urban development. It may not be practical to refuse all future development within existing urban areas falling within land which would flood during a 5% AEP event, and therefore careful consideration must be given to future sustainability.

4.2.14 Following a review of the fluvial Flood Zones across the borough of Milton Keynes Borough that are at risk of flooding during a 5% AEP event, it can be seen that these areas are largely undeveloped land. As such, it is considered appropriate to use the outline of the flood with the 5% AEP to define Flood Zone 3b Functional Floodplain. This has been presented on Figures B5 and C1-C9.

4.2.15 Milton Keynes was designed so that the majority of the functional and engineered floodplain is within linear parks. Since 1992 these have been managed by the Milton Keynes Parks Trust (MKPT), which has a 999 year lease on the land. As a result there are few properties lying with Flood Zones 2 and 3 within the town of Milton Keynes. Areas where there are properties within Flood Zones 2 or 3 include:

- Newport Pagnell, where there are several properties in Flood Zone 2 and 3 upstream of the Ouzel - River Great Ouse confluence. These include properties on Priory Street, Dove Close and Tickford Street located on the right bank of the Ouzel; properties on Riverside, St John Street, Silver Street, Caldecotte Street and Willen Road on the left bank of the Ouzel; and properties on Mill Street and Priory Street on the right bank of the River Great Ouse. Properties along Lakes Lane are within Flood Zone 3, but are shown to benefit from the presence of flood defences.
- New Bradwell, where there are properties in Flood Zone 3 associated with the Great Ouse on Newport Rd.
- Bletchley and Water Eaton, where there are properties in Flood Zone 2 or 3 for Water Eaton Brook in Bettina Grove, Frensham Drive and Larch Grove.

- Isolated properties along the Ouzel including Belvedere Farm (SP88603404), part of the Open University Campus at Walton Hall (SP88383707) and Caldecotte Mill (SP883704264). In addition there are properties in Flood Zone 3 in Willen on Milton Road, though this area is shown to benefit from flood defences.
- Stony Stratford, where there are properties in Flood Zone 3 on Ostlers Lane and Fegan's Court. Further properties in Mill Lane, the High Street, Magdalen Close and Willow Lane are in Flood Zone 2.
- Access to Olney from Bridge Street in the south of the settlement is within Flood Zone 3 associated with the Great Ouse and there are isolated properties along the Great Ouse within Flood Zone 3, including the Mill at Wolverton Mill (SP79504113) and Gallards Farm (SP86794638).
- Tongwell where there are properties in Flood Zone 3 from Tongwell Brook on Tongwell Lane, Dulwich Close, Tabard Gardens, Ranelagh Gardens, Alexandra Drive, Gladstone, Gladstone Close, and Marsh End Road.

Climate Change

4.2.16 A considerable amount of research is being carried out worldwide in an endeavour to quantify the impacts that climate change is likely to have on flooding in future years. Climate change may increase peak rainfall intensity and river flow, which could result in more frequent and severe flood events. 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.

4.2.17 Recommended contingency allowances for net sea level rises, and recommended national precautionary sensitivity ranges for peak rainfall intensity, peak river flow, offshore wind speed and wave height suitable for use in the planning system are derived from Department for Environment, Food and Rural Affairs FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts, October 2006[18] and presented in

[18] This document has now been superseded by Environment Agency Adapting to Climate Change: Advice for flood and coastal erosion risk management authorities, July 2011, but the allowances are considered suitable for use in the planning system. Further information can be found on the Environment Agency standing advice pages here: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/296964/LIT_8496_5306da.pdf

Table 4-3 and Table 4-4, (these values are subject to change in accordance with data from UKCP09).

Table 4-3 Recommended contingency allowances for net sea level rises (Net sea level rise (mm per year) relative to 1990)

	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
East of England, east midlands, London, south-east England (south of Flamborough Head)	4.0	8.5	12.0	15.0

Table 4-4 Recommended national precautionary sensitivity ranges for peak rainfall intensity, peak river flow, offshore wind speed and wave height

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%		
Offshore wind speed	+5%		+10%	
Extreme wave height	+5%		+10%	

4.2.18 As part of the hydraulic modelling studies for the fluvial watercourses in the borough of Milton Keynes Borough, simulations have been run for the 1% AEP (1 in 100 year event) including the implications of climate change based on these allowances. It should be noted that whilst the modelling of the annual probability events to generate the NPPF Flood Zones (and Flood Map for Planning) do not account for the presence of flood defences, the simulations including an allowance for climate change do tend to include the presence of existing flood defences. These simulations are available for the following watercourses; River Great Ouse, River Ouzel, River Tove, downstream part of the Water Eaton Brook and Tongwell Brook, Loughton Brook and the downstream part of the Broughton Brook.

4.2.19 The flood outline for the 1% AEP (1 in 100 year event) including climate change has been mapped for these watercourses on Figure B5 and C1 – C9.

4.2.20 It is clear that climate change will not markedly increase the extent of river flooding within most areas of the Milton Keynes Borough. However, there are a few places where the extent of flooding is noticeably increased when taking into account the effects of climate change. These areas include, the south western part of Newport Pagnell associated with the Tongwell Brook (Figure C7) and the eastern edge of Olney associated with the River Great Ouse (Figure C2).

4.2.21 It is important to note that these areas, as well as those areas that are currently at 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 Borough) carefully mitigates against the potential impact that climate change may have upon the risk of flooding to properties.

4.2.22 For this reason, all of the development control recommendations set out in Section 7 require all floor levels, access routes, drainage systems and flood mitigation measures to be designed with an allowance for climate change; and the potential impact that climate change may have over the lifetime of a proposed development should be considered as part of a site-specific FRA. This provides a robust and sustainable approach to the potential impacts that climate change may have upon the Borough over the next 100 years, ensuring that future development is considered in light of the possible increases in flood risk over time.

4.3 Flooding from Surface Water

4.3.1 Overland flow and surface water flooding typically arise following periods of intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems. It can run quickly off land and result in localised flooding. The NPPG states that a SFRA should identify areas at risk from surface water flooding and drainage issues, taking account of the surface water flood risk published by the Environment Agency as well other available information.

LiDAR Topographic Survey

4.3.2 Appendix B Figure B1 shows the topography of the Borough based on Light Detection and Ranging (LiDAR) data and provides a useful basis for understanding surface water flood risk in the area.

4.3.3 LiDAR is an airborne mapping technique, which uses a laser to measure the distance between the aircraft and the ground. Up to 100,000 measurements per second are made of the ground, allowing highly detailed terrain models to be generated at spatial resolutions of between 25cm and 2 metres. The data mapped in Figure B1 has a spatial resolution of 2m. The Environment Agency's LiDAR data archive contains digital elevation data derived from surveys carried out since 1998.

Historic Records of Surface Water Flooding

4.3.4 The Environment Agency has provided records of flooding, some of which relate to surface water flooding. These are shown in Figure B6 and summarised in Table 4-5.

Table 4-5 Environment Agency Records of Surface Water Flooding

Location	Date	Description
John Street, Newport Pagnell	Sep-92	Flooding from surface water drain surcharge.
Caldecote St, Newport Pagnell	Sep-92	Flooding from surface water drain surcharge.
Priory St, Newport Pagnell	Sep-92	Flooding from surface water drain surcharge.
Stoke Goldington	Jul-07	Pluvial. Excess surface water runoff. Drainage system overwhelmed. Source: Review of Summer 2007 Floods - Anglian Region.
Lavendon	Aug-08	Pluvial. Drainage system capacity exceeded. Source: Bedford Parish File.
Passenham	Jul-07	Pluvial. Excess surface water runoff. Drainage system overwhelmed. Source: Review of Summer 2007 Floods - Anglian Region.
The Green, Cosgrove	Apr-98	Water due to faulty drain rather than river flood.
Oxfield Park Drive, Old Stratford	Jul-04	Pluvial. Highway drainage system overwhelmed - lack of maintenance the cause. Source: Bedford Parish File.

4.3.5 The Highways Agency was consulted as part of the SFRA update and has provided information on incidents relating to flooding and standing water on the Highways Agency network from their command and control system. Incidents are recorded along the A5 as shown in Figure B6 and described in Table 4-6.

Table 4-6 Highways Agency Records of Flooding

Date	Easting	Northing	Description
05 Jul 2006	481344	239629	Flooding on Main Carriageway – Incident Support Unit called.
06 Jul 2006	482509	239258	Flooding on Slip Road Carriageway - Incident Support Unit called.
06 Nov 2006	489038	233852	Underpass flooding beneath the Main Carriageway due to blocked ditch.
01 Dec 2006	487195	235661	Flooding Main Carriageway across L1/2 n/b, c.res. And L1/2 s/b - Cut grips.
20 Jul 2007	488697	234450	Standing water on the Main Carriageway.
20 Jul 2007	479613	240646	Standing water on the Main Carriageway.
22 Feb 2010	488536	235296	Runoff from offside verge across Slip Road due to a blockage in the drainage system.

4.3.6 As discussed in Section 4.2 there is a history of overland flooding in Stoke Goldington due to runoff flowing over the fields. The flood investigation report for Stoke Goldington[19] found that the village is affected by overland runoff due to its location in a natural topographic hollow, and the local geology. The village is situated on relatively impermeable Upper Lias clay while higher land to the north and west of the village is generally situated upon boulder clay and limestone respectively. The clay soils will act as impermeable surfaces when saturated, or baked, leading to a high percentage of run off, which is toward the village due to the slope of the fields. The limestone geology to the west can retain significant volumes of rainfall. During an extended period of heavy rainfall this water can be released as natural springs on the local hillsides at the interface of the limestone and clay geology, and contribute to flooding.

Updated Flood Map for Surface Water

4.3.7 The Environment Agency has undertaken hydraulic modelling of surface water flood risk at a national scale and produced mapping identifying those areas at risk of surface water flooding during three annual probability events: 3.3% AEP (1 in 30 chance of flooding in any one year), 1% AEP and 0.1% AEP. The latest version of the mapping is referred to as the 'updated Flood Map for Surface Water' (uFMfSW) and the extents have been made available to MKC as Geographical Information System (GIS) layers. This dataset is also available of the Environment Agency website, and is referred to as 'Risk of Flooding from Surface Water'.

4.3.8 The uFMfSW provides all relevant stakeholders, such as the Environment Agency, MKC and the public access to information on surface water flood risk which is consistent across England and Wales[20]. The modelling helps the Environment Agency take a strategic overview of flooding, and assists MKC (as the LLFA) in their duties relating to management of surface water flood risk. For the purposes of this SFRA, the mapping allows an improved understanding of areas within MKC administrative area which may have a surface water flood risk.

4.3.9 The hydraulic modelling represents a significant improvement on previous mapping, namely the FMfSW (2010) and the Areas Susceptible to Surface Water Flooding (AStSWF) (2009), for example:

- Increased model resolution to 2m grid,

[19] WSP (2008) Stoke Goldington Flooding Investigation Stage 2 Report
[20] Environment Agency (2013) 'What is the updated Flood Map for Surface Water?'

- Representation of buildings and flow routes along roads and manual editing of the model for structural features such as flyovers,
- Use of a range of storm scenarios, and,
- Incorporation of appropriate local mapping, knowledge and flood incident records.

4.3.10 However, it should be noted that this national mapping has the following limitations:

- Use of a single drainage rate for all urban areas,
- It does not show the susceptibility of individual properties to surface water flooding,
- The mapping has significant limitations for use in flat catchments,
- No explicit modelling of the interaction between the surface water network, the sewer systems and watercourses,
- In a number of areas, modelling has not been validated due to a lack of surface water flood records, and,
- As with all models, the uFMfSW is affected by a lack of, or inaccuracies, in available data.

4.3.11 These datasets provide a picture of surface water flooding across the Borough and identify that incidents are widespread across most part of the Borough. The following areas are shown to be at particular risk, although the following list is by no means exhaustive:

- Surface water is shown to pond in natural low points within the fluvial floodplains, in particular of the River Great Ouse and the River Ouzel.
- Within the urban area of Milton Keynes, surface water flood risk is concentrated along the course of existing drains and small watercourses.
- In Newport Pagnell, the extent of surface water flooding is not so tightly constrained; a larger area of residential land to the west of the Bury Ground adjacent to Lakes Lane is shown to be at low to medium risk of surface water flooding.
- Surface water is shown to collect behind railway embankments, e.g. in the north western part of the Borough where tributaries of the River Tove flow across the route of the railway line, and in the south of the Borough where tributaries of the Caldecotte Brook flow northwards. These are mainly rural areas.

Climate Change

4.3.12 The uFMfSW does not include a specific scenario to determine the impact of climate change on the risk of surface water flooding. However, a range of three annual probability events have been undertaken, 3.3%, 1% and 0.1% and therefore it is considered appropriate to use the 0.1% AEP event as a substitute dataset to provide a worst case scenario and an indication of the implications of climate change.

4.3.13 Appendix D Figures D1 – D9 present the uFMfSW mapping for the borough of Milton Keynes Borough in combination with historical surface water flooding data recorded by the Environment Agency and Highways Agency.

4.4 Flooding from Groundwater

4.4.1 Groundwater flooding usually occurs in low-lying areas underlain by permeable rock and aquifers that allow groundwater to rise to the surface through the permeable subsoil following long periods of wet weather. Low-lying areas may be more susceptible to groundwater flooding because the water table is usually at a much shallower depth and groundwater paths tend to travel from high to low ground.

Historic Records

4.4.2 The Environment Agency hold records of historic flood events, including flooding from groundwater. These are shown in Figure B8 and summarised in Table 4-7.

Table 4-7 Environment Agency Records of Groundwater Flooding

Location	Date	Description
Mill Street, Newport Pagnell	Feb-03	Flooded basement due to high groundwater level. Source: GWCL Team Records.
Weston Road, Ravenstone	Apr-76	High water table. Source: Bedford Parish File.
War Memorial, Olney	Jun-69	Well overflow due to high water table. Source: Bedford Parish File.
High Street, Stony Stratford	Apr-98	Water entered through the ground. Wrack marks in garden.

4.4.3 Table 4-8 details the datasets that were supplied for the SFRA by the Environment Agency and the BGS regarding the underlying geology, the presence of groundwater and the risk of groundwater flooding.

Table 4-8 Geological and Groundwater Flood Risk Datasets

Source	Dataset Title	Figure No.
1	Superficial geology (British Geological Survey)	Figure B3
2	Bedrock geology (British Geological Survey)	Figure B4
3	Aquifer Type (Environment Agency)	-
4	Groundwater Vulnerability Classification (Environment Agency)	-
5	Groundwater Source Protection Zones (Environment Agency)	-
6	Susceptibility to Groundwater Flooding (BGS)	Figure B8
7	SuDS drainage potential – depths to water table (BGS)	-
8	SuDS drainage potential – infiltration constraints summary (BGS)	Figure B9
8	SuDS drainage potential – drainage summary (BGS)	Figure B9

4.4.4 In order to provide a strategic assessment of the risk of groundwater flooding in Milton Keynes, the following two stage assessment was undertaken using the data sources in Table 4-8.

4.4.5 The initial stage included a review of the GIS layers of the BGS superficial geology (Source 1) and bedrock geology (Source 2), the Environment Agency aquifer type (Source 3), groundwater vulnerability (Source 4) and Source Protection Zones (SPZ) maps (Source 5). The next stage was to use the GIS layer produced by the BGS showing areas susceptible to groundwater flooding (Source 6) on the basis of geological and hydrogeological conditions. A description of each of these datasets is provided below.

Aquifer Type (Source 3)

4.4.6 Aquifers are underground layers of water-bearing permeable rock or drift deposits from which groundwater can be extracted. The Environment Agency categorises aquifers as being principal aquifers, secondary aquifers and unproductive strata. Their definitions are as follows;

4.4.7 **Principal Aquifers:** Highest intergranular and/or fracture permeability which allow water to flow through them providing large levels of water storage. They may support water supplies or river base flow on a strategic scale.

4.4.8 Secondary Aquifers – types A, B or Undifferentiated:

- **A** – Permeable layers which may support water supply and or base flow to rivers on a local scale; and
- **B** – Lower permeability which may store and yield limited amounts of groundwater.
- **Undifferentiated** – Not possible to attribute to either type A or B due to variable characteristics of the rock type.

4.4.9 **Unproductive strata:** are characterised by low permeability with little ability to store or transmit groundwater.

4.4.10 Environment Agency datasets have been used to identify the presence of aquifers within the borough of Milton Keynes.

The north of Milton Keynes is underlain by the Blisworth Limestone Formation and Great Oolite Group which are designated as principal aquifers (predominantly limestone). Stretching from the west to north east the Kellaways and Cornbrash Bedrock Formations classed as Secondary A aquifers and Lias group and Rutland Formations designated as Secondary B aquifers.

4.4.11 In the far south eastern limit of the city boundary is the Woburn Sands, part of the Lower Greensand Formation. The Woburn Sands are designated as a principal aquifer and is used for public water supply.

4.4.12 The superficial deposits which follow the main watercourses including River Terrace Deposits and Alluvium are both also classed as Secondary A aquifers, with the surrounding Head on the fringes of these deposits classed as Secondary Undifferentiated aquifers.

Groundwater Vulnerability Classification (Source 4)

4.4.13 Groundwater Vulnerability Classifications are an Environment Agency dataset that broadly show the extents of aquifers in the Borough. Where aquifers are highly vulnerable, they often have a more permeable covering and, together with dry valley and watercourse networks, potential groundwater flooding areas can be identified.

Source Protection Zone (Source 5)

4.4.14 The Environment Agency defines SPZs around all major public and private water supply abstractions in order to safeguard groundwater resources from potentially polluting activities. The Environment Agency records of smaller abstractions have not been reviewed at this stage.

Susceptibility to Groundwater Flooding

4.4.15 Based on the current hydrogeological conceptual understanding, there is the potential for groundwater flooding to occur within the Milton Keynes Borough. There are three key groundwater flooding mechanisms that have been identified:

Surface water – Groundwater interaction within superficial aquifers along the River Ouzel, the River Great Ouse and their tributaries. Groundwater flooding may be associated with the Alluvium, River Terrace Deposits and the Head deposits where they are in hydraulic continuity with these surface watercourses. Stream levels may rise following high rainfall events but still remain "in-bank", and this can trigger a rise in groundwater levels in the associated superficial deposits.

Direct groundwater recharge to superficial and bedrock aquifers. During periods of high rainfall, perched water tables can exist within these deposits, developed through a combination of natural rainfall recharge and artificial recharge e.g. leaking water mains.

Made ground in various locations: a final mechanism for groundwater flooding may occur where the ground has been artificially modified to a significant degree. If this 'made ground' is of substantial thickness and permeability, then a shallow perched water table may exist. This could potentially result in groundwater flooding at properties with basements, or may equally be considered a drainage issue. Areas mapped by the BGS as containing made ground deposits are found both on the superficial deposits and directly on the bedrock and may either form a continuous aquifer with respective aquifer horizons, or provide a low permeability cap constraining recharge to and seepage from such horizons, depending on the composition of the made ground.

4.4.16 Appendix B Figure B8 presents a dataset produced by the BGS showing areas susceptible to groundwater flooding (Source 6) on the basis of geological and hydrogeological conditions. This layer is divided into three classes – High, Medium and Low risk. The highest risk areas are those with the potential for groundwater flooding to occur at the surface, medium risk are those which may experience groundwater flooding of property situated below the ground surface i.e. basements; and low risk are those with limited potential for groundwater flooding to occur. Some areas are not considered to be at risk of groundwater flooding.

4.4.17 In the north, where the underlying geology is predominantly limestone or the Kellaways Formation and Oxford Clay Formation there is a limited potential for groundwater flooding to occur.

4.4.18 The bedrock geology of the central and southern parts of the Borough is predominantly Oxford Clay which is relatively impermeable. As a result areas which sit directly on the clay are not considered to be at risk from groundwater flooding.

4.4.19 Along and adjacent to the watercourses throughout the Borough there is an increased potential for groundwater flooding to occur in the River Terrace Deposits and Alluvium due to the higher permeability of these formations and associated high groundwater levels in adjacent areas.

SuDS Suitability

4.4.20 The BGS has also produced a data set of infiltration SuDS mapping. The GIS layers from this dataset that were used included the infiltration SuDS drainage potential (including the depth to water table – Source 7), the infiltration constraints summary (identifying areas with very significant constraints – Source 8) and the drainage summary (identifying areas with very significant constraints, areas with opportunities for bespoke infiltration SuDS and areas through to be highly compatible for infiltration SuDS – Source 9). This information is shown in Appendix B Figure B9 and further guidance about the applications of infiltration SuDS is included in Section 8.

4.5 Flooding from Sewers

4.5.1 During and following heavy rainfall, flooding from the sewer system may occur if:

(1) The rainfall event exceeds the capacity of the sewer system/drainage system:

4.5.2 Sewer systems are typically designed and constructed to accommodate rainfall events with a 3.3% AEP or less. Therefore, rainfall events with a return period of frequency greater than 3.3% AEP would be expected to result in surcharging of some of the sewer system. While AWS, as the sewerage undertaker for Milton Keynes, are concerned about the frequency of extreme rainfall events, it is not economically viable to build sewers that could cope with every extreme rainfall event.

(2) The system becomes blocked by debris or sediment:

4.5.3 Over time there is potential that road gullies and drains become blocked from fallen leaves, build-up of sediment and debris (e.g. litter).

(3) The system surcharges due to high water levels in receiving watercourses:

4.5.4 Within the Borough there is potential for surface water outlets to become submerged due to high river levels. When this happens, water is unable to discharge. Once storage capacity within the sewer system itself is exceeded, the water will overflow into streets and potentially into houses. Where the local area is served by 'combined' sewers i.e. containing both foul and storm water, if rainfall entering the sewer exceeds the capacity of the combined sewer and storm overflows are blocked by high water levels in receiving watercourses, surcharging and surface flooding may again occur but in this instance floodwaters will contain untreated sewage.

Historic Records

4.5.5 AWS has provided an extract from their DG5 Flood Register for the borough of Milton Keynes. Due to data protection requirements the data has not been provided at individual property level; rather the register comprises the number of properties within 4 digit postcode areas that have experienced flooding either internally or externally within the last 10 years.

4.5.6 Appendix B Figure B7 shows records of 2 properties affected by internal flooding in the areas of Fenny Stratford and Stony Stratford. External flooding has affected 1 property in each of the following 4 areas; Denbigh North, Bletchley, Woburn Sands and Moulsoe / southern Newport Pagnell. It should be noted that records only appear on the DG5 register where they have been reported to AWS, and as such they may not include all instances of sewer flooding. Furthermore given that AWS target these areas for maintenance and improvements, areas that experienced flooding in the past may no longer be at greatest risk of flooding in the future.

4.6 Flooding from Reservoirs, Canals and Other Artificial Sources

Canals

4.6.1 The Grand Union Canal passes the through the borough of Milton Keynes as shown in Appendix B Figure B2. Consultation with Canal and River Trust has provided 2 records of failures (breaches) and 2 records of overtopping on the Grand Union Canal, the location of which are shown in Figure B2 and descriptions of which are as follows:

- Record 1: The Ouse Aqueduct collapsed in 1808 and debris blocked the River Great Ouse, threatening Stony Stratford with the potential for a major flood. In the event the flood did not happen as the river found a course around the blockage.

- Record 2: A breach incident occurred in the Wroughton Park area (SP8779836717) in 1971 caused by third party works involving the installation of pipes across the canal.
- Record 3: In July 2007, heavy rainfall and high levels resulted in overtopping of the canal to the north of Grafton Regis just to the west of the Milton Keynes Borough boundary in South Northamptonshire. The River Tove surcharged past weir capacity and before flood paddles were raised.
- Record 4: In January 2013 snow melt and a rapid rise in the level of the River Tove resulted in overtopping of the canal immediately to the west of Grafton Regis just to the west of the Milton Keynes Borough boundary in South Northamptonshire. Overtopping affected a kilometre length of towpath in this location.

The proposed route for the Milton Keynes to Bedford canal is also shown in Appendix B Figure B2. Reservoirs

4.6.2 The failure of a reservoir has the potential to cause catastrophic damage due to the sudden release of large volumes of water. The NPPG encourages LPAs to identify any impounded reservoirs and evaluate how they might modify the existing flood risk in the event of a flood in the catchment it is located within, and / or whether emergency draw-down of the reservoir will add to the extent of flooding.

4.6.3 The Environment Agency dataset 'Risk of Flooding from Reservoirs' identifies areas that could be flooded if a large[21] reservoir were to fail and release the water it holds. The mapping shows that the following reservoirs could result in flooding in the borough of Milton Keynes:

- Caldecott Lake
- Willen Lake
- Simpson Balancing Reservoir
- Furzton Balancing Lake
- Tongwell Lake
- Bradwell Lake
- Loughton Lake
- Foxcote (Buckinghamshire County)
- Wakefield Lodge (Northamptonshire County)
- Towcester Flood Storage Reservoir (Northamptonshire County)
- Foscott (Buckinghamshire County)

4.6.4 The areas shown to be at risk of flooding are constrained to the floodplain areas of the Loughton Brook, Broughton Brook, Great Ouse and River Ouzel, due to the natural topography of the area.

4.6.5 Reservoirs in the UK have an extremely good safety record. The Environment Agency is the enforcement authority for the Reservoirs Act 1975 in England and Wales. All large reservoirs must be inspected and supervised by reservoir panel engineers. It is assumed that these reservoirs are regularly inspected and essential safety work is carried out. These reservoirs therefore present a managed risk.

4.6.6 MKC is responsible for working with members of the Local Resilience Forum (LRF) to develop emergency plans for reservoir flooding and ensuring communities are well prepared.

[21] A large reservoir is one that holds over 25,000 cubic metres of water, equivalent to approximately 10 Olympic sized swimming pools.

4.7 Flood Risk Management Measures

4.7.1 Flood risk management can reduce the probability of occurrence through the management of land, river systems and flood defences, and reduce the impact through influencing development in flood risk areas, flood warning and emergency response.

Flood Risk Management Polices

4.7.2 The Anglian River Basin District FRMP[22] has been published for consultation by the Environment Agency and sets out the proposed measures to manage flood risk in the Anglian River Basin District from 2015 to 2021 and beyond. This has drawn on existing information from the Catchment Flood Management Plan (CFMP).

4.7.3 A CFMP is a high-level strategic plan through which the Environment Agency seeks to work with other key decision-makers within a river catchment to identify and agree long-term policies for sustainable flood risk management.

4.7.4 The Great Ouse CFMP[23] covers the Milton Keynes Borough and identifies different policies for different 'sub-areas' of the River Great Ouse catchment. These policies are considered using a catchment approach rather than for independent sub-areas, for example the CFMP states that there is an opportunity to reduce flood risk in the Fens, in the lower part of the River Great Ouse catchment, by storing water in the upper parts of the Great Ouse catchment.

4.7.5 The administrative area of Milton Keynes falls within three CFMP sub-areas. The policies and actions for each sub-area are summarised in Table 4-9.

Table 4-9 Great Ouse CFMP sub-areas with flood risk management policies and actions

Sub-area 1 Bedford Ouse Rural (Policy 3): Areas of low to moderate flood risk where existing flood risk is generally being managed effectively.
General actions across the sub-area
Investigate opportunities to reduce current levels of flood risk management on the main rivers in this sub-area.
Continue with current levels of flood risk management on all ordinary watercourses (including Award Drains) in this sub-area.
Ensure any policies within the Local Development Framework or any revisions are in line with the CFMP policy.
Continue with improvements to the flood warning service by extending the current Floodline Warnings Direct service and through the creation of community-based flood warnings.
Work with partners to develop emergency response plans for critical infrastructure, community facilities and transport links at risk from flooding.
Ensure that opportunities are taken within minerals and waste development/action plans to use mineral extraction sites to store flood water.
Produce land management plans to explore opportunities to change land use and develop sustainable land management practices.
Develop environmental enhancement projects to improve the natural state of the rivers and their habitats.

[22] Environment Agency (October 2014) Anglian River Basin District Consultation on the draft Flood Risk Management Plan https://consult.environment-agency.gov.uk/portal/ho/flood/draft_frmp/consult?pointId=3063510
[23] Environment Agency, January 2011, Great Ouse Catchment Flood Management Plan.

Sub-area 2 Great Ouse River Corridor (Policy 6): Areas of low to moderate flood risk where we will take action with others to store water or manage run off in locations that provide overall flood risk reduction or environmental benefits.
General actions across the sub-area
Encourage planners to locate new development outside the flood plain. The flood plain should be maintained as an asset to make space for water.
Work with partners to develop emergency response plans for critical infrastructure, community facilities and transport links at risk from flooding.
Actions specific to the Great Ouse River Corridor
Investigate developing a strategic flood storage study to consider creating/developing storage within the Great Ouse river corridor. The study should investigate the most appropriate storage options and locations for flood plain storage.
In the short-term continue with current activities to manage flooding through the settlements, and outside of these areas investigate opportunities to reduce maintenance activities.
Continue with improvements to the flood warning service by extending the current Floodline Warnings Direct service and through the creation of community based flood warnings.
Reduce the consequences of flooding by improving public awareness of flooding and encouraging people to sign up to, and respond, to flood warnings.
Ensure that opportunities are taken within minerals and waste development/action plans to use mineral extraction sites to store flood water.
Develop environmental enhancement projects to improve the natural state of the rivers and their habitats.
Sub-area 3 Milton Keynes/The Stratfords/Newport Pagnell (Policy 5): Areas of moderate to high flood risk where further action can generally be taken to reduce flood risk.
General actions across the sub-area
In the short-term, continue with current levels of flood risk management on all watercourses.
Work with partners to develop emergency response plans for critical infrastructure, community facilities and transport links at risk from flooding.
Continue with improvements to the flood warning service by extending the current Floodline Warnings Direct service.
Actions specific to Milton Keynes / The Stratfords / Newton Pagnell
Develop a flood risk study for Milton Keynes, the Stratfords and Newport Pagnell to investigate options to reduce flooding.
Reduce the consequences of flooding by improving public awareness of flooding and encouraging people to sign up to, and respond, to flood warnings.
Consider developing a surface water management plan for Milton Keynes.
Develop environmental enhancement projects to improve the natural state of the rivers and their habitats.
Ensure any policies within the Local Development Framework or any revisions are in line with the CFMP policy.

Flood Defences

4.7.6 Flood defences are structures which affect flow in times of flooding and therefore reduce the risk water from entering property. They generally fall into one of two categories; 'formal' or 'informal', as described further below.

4.7.7 A 'formal' flood defence is a structure which has been specifically built to control floodwater. It is maintained by its owner or statutory undertaker so that it remains in the necessary condition to function. In accordance with the Flood and Water Management Act 2010, the Environment Agency and IDB have powers to construct and maintain defences to help against flooding. MKC has similar powers on ordinary watercourses outside the IDB areas. AWS also operate a number of assets (such as balancing lakes) within the area to control flows which act a flood defence mechanism. The City of Milton Keynes has a unique system in place for drainage and flood risk management. The individual balancing lakes within Milton Keynes form part of the whole strategic drainage/flood defence mechanism for Milton Keynes. The watercourses and brooks throughout the designated urban area were heavily engineered so as to form part of the flood defence/mitigation system. Therefore it is the whole system, the balancing lakes, the engineered brooks etc. which work together as one formal flood defence system.

4.7.8 An 'informal' defence is a structure that has not necessarily been built to control floodwater and is not maintained for this purpose. This includes road and rail embankments and other linear infrastructure (buildings and boundary walls) which may act as water retaining structures or create enclosures to form flood storage areas in addition to their primary function.

4.7.9 Identification of informal flood defences has not been carried out as part of this assessment. Should any changes be planned in the vicinity of road or railway crossings over rivers in the Borough it would be necessary to assess the potential impact on flood risk to ensure that flooding is not made worse either upstream or downstream. Smaller scale informal flood defences should be identified as part of site-specific FRAs and the residual risk of their failure assessed.

4.7.10 In accordance with the scope of a Level 1 SFRA, a high level review of formal flood defences has been carried out using data from the Environment Agency Asset Information Management System (AIMS). This dataset contains details of flood defence assets associated with main rivers and provides a good starting point for identifying significant local defences and potential areas benefiting from defences, but the quantity and quality of information provided differs considerably between structures. The AIMS is intended to provide a reasonable indication of the condition of an asset and should not be considered to contain consistently detailed and accurate data (this would be undertaken as part of a Level 2 SFRA or site-specific FRA where the need arises).

4.7.11 As part of the Upper Great Ouse hydraulic modelling study, a standard of protection (SoP) and areas benefiting from defences assessment was commissioned.

Table 4-10 provides a summary of the SoP for each defence and the return periods the defence was shown to overtop.

Table 4-10 Environment Agency Flood defences along the River Great Ouse (taken from AIMS)

Defence Name	Minimum Crest Level (m)	Maximum Crest Level (m)	Standard of Protection	Maximum Water Levels	Comments
Kickles Lodge	57.16	57.43	1000yr	55.91	Not overtopped for the 1000yr event
Castle Meadow	55.36	56.68	1000yr	55.23	Not overtopped for the 1000yr
Willen Road	55.50	55.52	200yr	55.16	Overtops between 200yr and 1000yr
Willen Road Bridge 01	55.41	55.62	5yr	55.59	Overtops between 5yr and 10yr events
Willen Road Bridge 02	55.58	55.73	25yr	55.52	Overtops between 25yr and 50yr events
Willen Lake 01	61.24	63.12	1000yr	0	Not overtopped for the 1000yr event
Willen Lake 02	58.94	64.8	200yr	58.9	Overtops between 200yr and 1000yr events
Middleton	61.58	61.65	1000yr	60.69	Not overtopped for the 1000yr event
Woolstone	60.6	62.15	100yr	60.6	Overtops between 100yr and 200yr events
Caldecote Lake	64.68	69.43	1000yr	65.88	Not overtopped for the 1000yr event; overtopped at spillway only between 5yr and 10yr event
Sports Ground (Bletchley Town Cricket Club)	60.04	67.36	0yr	66.26	Overtops between 0 and 5yr events

4.7.12 There are raised defences within the Borough at Newport Pagnell, Middleton and Fenny Stratford. In Newport Pagnell there is a raised embankment on the right bank of the River Great Ouse at Kickles Bank (SP86624469), which has a SoP of 1 in 50 years. The Environment Agency GIS layers of areas that benefit from defences (ABDs) show that the area behind Kickles Bank, including most of Lakes Lane, is an ABD as the 1 in 100 year water levels in the Great Ouse are 60cm lower than Kickles Bank. As described in Section 4.2, there was considerable flooding to this area in the 1998 and 1947 floods, prior to the construction of the current defence. There are further raised embankments with a SoP of 1 in 50 years on the right bank of Tongwell Brook along Willen Rd (SP 87734314). On left bank of the River Ouzel there are defences along Willen Road and Caldecotte Street (SP87574342) with a SoP of 1 in 50 years which are partly comprised of the walls of adjacent buildings. There are raised embankments on the right bank of the River Ouzel along Priory Street (SP 87954390) with a 1 in 50 year SoP.

4.7.13 There is a raised embankment on the left bank of the River Ouzel (SP88203936). This has a SoP of 1 in 200 years and was built to enable development of the English Partnership Site at Middleton.

4.7.14 The area to the east of Tickford Bridge around Priory Street in Newport Pagnell benefits from defences as do areas along Willen Road and Caldecote Street.

4.7.15 In Milton Keynes the area around Woolstone benefits from defences and is protected up to the 1% AEP event, shown below. However these defences may be bypassed during the 2% AEP (1 in 50 year) event.

4.7.16 Along the River Ouzel, the Environment Agency GIS layers of ABDs include parts of Woodall Close and Bereville Crescent in Fox Milne, and parts of Milton Road in Willen.

4.7.17 If there are proposed developments behind defences and downstream of the balancing lakes, it may be necessary to extend the scope of the SFRA to Level 2. The outputs from detailed overtopping and breach analysis of the key defences will provide refined hazard information on flood depths, velocities and flow paths, which could be used by the LPA emergency planning teams to define new or refine existing emergency plans for these areas.

Engineered Watercourses, Public storm sewers and Balancing Lakes

4.7.18 A primary objective in the original design of the City of Milton Keynes was that its development should not make flooding worse than that which would be experienced had the development not taken place. To achieve this, a series of balancing lakes were constructed on the River Ouzel, Loughton Brook and Tongwell Brook. These lakes compensate for increased runoff from urban areas and recreate storage that was lost as a result of floodplain development. The original design criteria was that storage on Loughton Brook should be designed for storms of a frequency of 1 in 10 years to 1 in 15 years, and that storage on the River Ouzel should be designed for the capacity required if there was a recurrence of the 1947 floods. The balancing lakes are described in Table 4-11.

4.7.19 The principal balancing lakes on the River Ouzel are the Caldecotte and Willen Lakes which have control gates to regulate the flow in the River Ouzel. They were built to compensate for increased flows in Broughton Brook and increased discharge from the sewage treatment works, as well as increased run off flows in the River Ouzel.

4.7.20 A strategic study of the system of balancing lakes within Milton Keynes was completed by Halcrow in February 2000 and revised to include updated Flood Estimation Handbook (FEH) hydrology in 2003. This aimed to assess how the system served the existing development within Milton Keynes as the original planned new town reached completion, to identify the impacts of future developments on flood risk downstream of Milton Keynes, and to identify sustainable drainage solutions for future incorporation. These reports found that the impermeable area in Milton Keynes had increased slightly over that originally envisaged, but that due to hydrological methodology at the time, the original design approach had been overly conservative so that the system met its design criteria with the current level of runoff. During the development of Milton Keynes, watercourses were heavily modified so as to manage and mitigate flood risks both throughout Milton Keynes and downstream which may arise in the future as a result of new development. These heavily modified watercourses play an important role in the overall flood risk management of Milton Keynes and the strategic drainage network.

Table 4-11 Flood Storage Areas, Balancing Lakes and Reservoirs in Milton Keynes

Reservoir	Catchment	Grid Ref.	Type	Line	Capacity (m^3)	Catchment Area (Ha)	Notes
Willen	Ouzel	SP8800840244	Wet	Off	943000	27700	Completed in 1977. Operation of control gates depends on flow increased upstream of the DA and downstream of Willen Lake. Flow in Broughton Brook also monitored.
Caldecotte	Ouzel	SP8902435172	Wet	Off	570000	25500	Operation of control gates depends on flow increased upstream of the DA and downstream of Willen Lake. Flow in Broughton Brook also monitored.
Simpson	Ouzel	SP8765635900	Wet / Dry	On	170000	525	Also known as Ashlands. Built prior to 1977. Operates on similar basis to Loughton.
Mount Farm	Ouzel	SP8761734962	Wet	On	31500	262	-
Walton	Ouzel	SP8808637067	Wet	Off	66000	279	-
Water Eaton	Ouzel	SP872328	Wet / Dry	Off	3000	62	-
Tongwell	Tongwell Brook	SP8683142346	Wet	Off	165000	529	Designed in 1973. Peak inflow is 38 cumecs. Peak outflow is 1.42 cumecs.
Bradwell Lake	Loughton Brook	SP8325242588	Wet / Dry	On	235000	4030	Built in 1972. Overtops at time of high flows. DW looked at changes to high level outlet in 1979. Designed on basis of 100% and 70% run off.
Loughton (Tear Drop Lakes)	Loughton Brook	SP8471137109	Wet / Dry	On	291000	2380	Built in 1977. Designed on basis of 100% and 70% run off.
Furzton	Loughton Brook	SP8471835949	Wet / Dry	On		1886	Built after 1982. Design discharge determined to control flows downstream.
Lodge Lake	Loughton Brook	SP8313738391		On	67000		Built in 1981. This was constructed to provide short term storage as a flood meadow. Necessary to deal with high flows arising from increased developed areas. Designed on basis of 100% and 70% run off.
Brick Kiln	Ouse	SP799405	Wet / Dry	On		206	First to be constructed. Fissured limestone in base results in loss of stored water due to seepage.

Residual Risk

4.7.21 In producing Flood Zone maps the Environment Agency takes the presence of defences into account by showing the ABDs. This area can also be deemed an area which is at risk of defence overtopping or failure. It can therefore also be described as a residual risk zone. Residual flood risks can arise due to:

- The failure of flood management infrastructure such as a breach of a raised flood defence, blockage of a surface water conveyance system or culvert, overtopping of an upstream storage area, or failure of a pumped drainage system
- A severe flood event that exceeds a flood management design standard and results in, for example, overtopping.

4.7.22 Within the borough of Milton Keynes there are ABDs contained within the Environment Agency's ABD database at Kickles Bank and Priory Street in Newport Pagnell, as well as Milton Road in Willen and Woodall Close / Bereville Crescent in Fox Milne. No ABDs have been mapped for the flood storage areas on the River Ouzel. With each defence, including the flood storage areas/balancing lakes/reservoirs, there is a residual risk of overtopping, breach or blockage, which could result in significant damage to buildings and highway infrastructure as well as posing danger to life.

4.7.23 It is possible that future modelling or analysis work undertaken by the Environment Agency may lead to the identification of further ABDs for other areas, and therefore the flood maps should be updated if this information becomes available. Areas of residual risk are treated uniformly and are represented in the GIS as a simple outline of the expected affected area. Actual levels of residual risk will vary spatially depending on flow routes, velocities, flood depths and proximity to the breach or overtopping location. In the event that the Exception Test needs to be applied to specific site allocations in identified residual risk areas, the scope of the SFRA should be extended to a Level 2 assessment to refine information on the flood risk to include depth and hazard information in these locations.

4.7.24 There is a residual risk of overtopping or breach of the Grand Union Canal and the balancing lakes. The area at risk from these events has not been mapped within this SFRA. However, although the risk of failure is small, the potential for a large volume of water to be released quickly means that the hazard downstream of these structures is high. Where possible, development should therefore be avoided immediately downstream of the balancing lakes. Where no other development sites are available a detailed breach and overtopping analysis will be necessary to determine the flood hazard and inundation area, and this should be included in the scope of the Level 2 SFRA.

4.7.25 Flood defences and culverted section of watercourse are mapped in Appendix C Figures C1 – C9. These should be referenced by those proposing development to identify the possibility of localised residual risks as well as opportunities for de-culverting and restoring the natural channel.

Flood Warning Systems

4.7.26 The Environment Agency provides a free flood warning service for many areas at risk of flooding from rivers and the sea. In some parts of England the Environment Agency may be able to provide warnings when flooding from groundwater is possible. The Environment Agency free flood warning service can provide advance notice of flooding and can provide time to prepare.

4.7.27 The Environment Agency issue flood warnings to homes and businesses when flooding is expected. Upon receipt of a flood warning, occupants should take immediate action.

4.7.28 The Environment Agency issue flood alerts when flooding is possible. Flood alerts cover larger areas that flood warnings and are issued more frequently. Upon receipt of an alert, occupants should be prepared for flooding and to take action.

4.7.29 If a flood alert from groundwater is available this does not mean that a particular property is definitely at risk. It is very difficult to predict the exact location of flooding from groundwater as it is often related to local geology. To help people, the Environment Agency provides flood alerts for large areas that could be affected if groundwater levels were high.

4.7.30 There are 3 flood alert areas and 12 flood warning areas within the Borough, as shown in Figure B10.

Flood Response Plan

4.7.31 MKC's Emergency Planning Department is responsible for the production, maintenance, and development of plans for an integrated response to any major emergency. This involves working closely with the emergency services, other Council departments, other local authorities, voluntary agencies and industry to ensure that any response to a major incident is carefully managed to ensure a return to normality as quickly as possible. The MKC includes flooding as an emergency situation. MKC has a generic Major Emergency Response Plan which is the main guidance for all key officers in dealing with major emergencies. All departments should have emergency procedures in place to guide staff in their tasks where they differ from their normal work practices, such as providing care for evacuees at Emergency Rest Centres. MKC appoints an Incident Director to manage the authority's involvement during the initial phase of an emergency.

4.7.32 With regard to MKC's advice on flooding, the website directs users to the Environment Agency website to view the flood warnings in place (as described in Section 6.4) and to view properties at risk of flooding from main rivers (as described in Section 4.3). The Council's website offers a link to the Environment Agency's website for advice on how to protect homes from flooding, and provides information on what to do in event of a flood. The Council keeps a stock of 400 sandbags which can be obtained out of hours by calling the Council's Community Alarm phone number 01908 226699.

4.7.33 It is recommended that the Council's Emergency Response Plan is reviewed and updated in light of the findings of the SFRA to ensure that safe evacuation and access for emergency services is possible during times of flood both for existing developments and those being promoted as possible sites within the Local Plan process. It is further recommended that the Local Authority works with the Environment Agency to promote the awareness of flood risk to maximise the number of people signed up to the FWD service (previously this has involved targeted mail shots to those identified as living within Flood Zone 3a). Within the study area particular attention should be given to vulnerable people including those with impaired hearing or sight and those with restricted mobility.

4.7.34 With respect to new developments, those proposing the development should take advice from the LPAs emergency planning officer and for large-scale developments, the emergency services, when producing an evacuation plan as part of a FRA. As a minimum these plans should include information on:

4.7.35 How flood warning is to be provided:

- Availability of existing warning systems;
- Rate of onset of flooding and available warning time; and,
- Method of dissemination of flood warning.

4.7.36 What will be done to protect the infrastructure and contents:

- How more easily damaged items could be relocated;
- The potential time taken to respond to a flood warning;
- Ensuring safe occupancy and access to and from the development;
- Occupant awareness of the potential frequency and duration of flood events;
- Provision of safe (i.e. dry) access to and from the development;
- Ability to maintain key services during an event;
- Vulnerability of occupants and whether rescue by emergency services may be necessary and feasible; and,
- Expected time taken to re-establish normal practices following a flood event.

4.7.37 More information is provided in Section 7.3.

5 FLOOD RISK MANAGEMENT POLICY CONSIDERATIONS

5.1 Policy Considerations

5.1.1 A key aim of a SFRA is to define flood risk management objectives and identify key policy considerations. It should be noted that it is ultimately the responsibility of the MKC to formally formulate these policies and implement them.

5.1.2 It is recommended that the following flood risk objectives are taken into account during the policy making process. Guidance on how these objectives can be met throughout the development control process for individual development sites is included within Section 7.3.

5.1.3 Flood Risk Objective 1: To Seek Flood Risk Reduction through Spatial Planning and Site Design:

- Use the Sequential Test to locate new development in areas of lowest risk, giving highest priority to Flood Zone 1.
- Use the Sequential Test within development sites to inform site layout by locating the most vulnerable elements of a development in the lowest risk areas. For example, the use of low-lying ground in waterside areas for recreation, amenity and environmental purposes can provide an effective means of flood risk management as well as providing connected green spaces with consequent social and environmental benefits.
- Avoid development immediately downstream of flood storage reservoirs which will be at high hazard areas in the event of failure.
- Seek opportunities for new development to achieve reductions to wider flood risk issues where possible, e.g. larger developments may be able to make provisions for flow balancing within new attenuation SuDS features.
- Identify long-term opportunities to remove development from the floodplain through land swapping.
- Build resilience into a site's design (e.g. flood resistant or resilient design, raised floor levels).
- Ensure development is 'safe'. For residential developments to be classed as 'safe', dry pedestrian egress out of the floodplain and emergency vehicular access should be possible. Dry pedestrian access/egress should be possible for the 1 in 100 year return period event, and residual risk, i.e. the risks remaining after taking the sequential approach and taking mitigating actions, during the 1 in 1000 year event, should also be 'safe'.

5.1.4 Flood Risk Objective 2: To Ensure Surface Water Runoff from New Developments remains at Greenfield Rates:

- SuDS required on all new development. As outlined in Section 8 which outlines appropriate SuDS techniques for Milton Keynes, the current policy for the existing allocated sites within the Designated Area (DA) of Milton Keynes to use AWS sewers to connect to strategic SuDS should be the preferred means of surface water disposal. All new allocations e.g. the expansions areas and sites outside the DA in the rest of the Milton Keynes Council Area will be required to develop a strategy for providing SuDS. This will need to be on an integrated and strategic scale and where necessary will require the collaboration of all developers involved in implementing a specific expansion area or site. Above ground attenuation, such as balancing ponds, should be considered in preference to below ground attenuation, due to the water quality and biodiversity benefits they offer.
- All sites require the following:
    - Use of SuDS (where possible use of strategic SuDS should be made)

- Discharge rates should be restricted to Greenfield rates as a maximum.
- Brownfield sites should seek to discharge surface water from the redeveloped site at Greenfield rates wherever possible. At the least, betterment should be offered (in terms of reduced runoff) for all redeveloped sites.
- 1 in 100 year attenuation of surface water, taking into account climate change

- Space should be specifically set aside for SuDS and used to inform the overall layout of development sites.
- Promote environmental stewardship schemes to reduce water and soil runoff from agricultural land.
- Surface water drainage proposals should have a clear plan for the long term maintenance and adoption of the systems, prior to approval of any planning permission in line with national planning policy.

5.1.5 Flood Risk Objective 3: To Enhance and Restore the River Corridor:

- An assessment of the condition of existing assets (e.g. bridges, culverts, river walls) should be made. Refurbishment and/or renewal of the asset should ensure that the design life is commensurate with the design life of the development. Developer contributions should be sought for this purpose.
- Those proposing development should look for opportunities to undertake river restoration and enhancement as part of a development to make space for water. Enhancement opportunities should be sought when renewing assets (e.g. de-culverting, the use of bio-engineered river walls, raising bridge soffits to take into account climate change)
- Avoid further culverting and building over culverts. Where practical, all new developments with culverts running through their site should seek to de-culvert rivers for flood risk management and conservation benefit. Any culverting or works affecting the flow of a watercourse requires the prior written consent of either the Environment Agency (for main rivers), or MKC/IDB (for ordinary watercourses) under the terms of the Land Drainage/Water Resources Act 1991 and Flood and Water Management Act 2010. These regulatory bodies seek to avoid culverting, and their consent for such works will not normally be granted except as a means of access.
- Set development back from rivers, seeking a 9 metre wide undeveloped buffer strip for development by all watercourses including those where the Flood Zone does not exist. Under the terms of the Water Resources Act 1991 and the Land Drainage Byelaws the prior written consent of the Environment Agency, IDB or MKC is required for any proposed works or structures in, under, over or within 9 m from a main river or ordinary watercourse asset or structure. This is to allow easy maintenance of the water course, and includes consent for fencing, planting and temporary structures.

5.1.6 Flood Risk Objective 4: To Protect and Promote Areas for Future Flood Alleviation Schemes

- Protect Greenfield functional floodplain from future development (our greatest flood risk management asset) and reinstate areas of functional floodplain which have been developed (e.g. reduce building footprints or relocate to lower flood risk zones).
- Develop appropriate flood risk management policies for the Brownfield functional floodplain, focusing on risk reduction.
- Identify sites where developer contributions could be used to fund future flood risk management schemes or can reduce risk for surrounding areas.
- Seek opportunities to make space for water to accommodate climate change.

5.1.7 Flood Risk Objective 5: To Improve Flood Awareness and Emergency Planning

- Seek to improve the emergency planning process using the outputs from the SFRA.
- Encourage all those within existing Flood Zone 3a and 3b (residential and commercial occupiers) to sign up to Flood Warnings Direct service operated by the Environment Agency.
- Ensure robust emergency (evacuation) plans are implemented for new developments greater than 1 hectare (Ha) in size.

5.2 Council Specific Policy Issues

5.2.1 It is recommended that the aforementioned policy considerations are included in the MKC's policies. In addition the Council should seek to:

- Maintain the current system of linear parks, providing development free corridors along water courses;
- Investigate whether the proposed level of infill development can be accommodated with the existing system of balancing lakes, and using the existing storm water drainage network; and,
- Encourage the use of strategic SuDS where possible.

5.3 Sensitive Development Locations

5.3.1 In general, throughout the borough of Milton Keynes, any development (including developments in Low Probability Flood Zone 1) which does not incorporate SuDS may increase the risk of surface and/or fluvial flooding both on-site and off-site (downstream). As such effective planning policies should be implemented in accordance with the SuDS recommendations provided in this report.

5.3.2 The core spatial strategy identifies 8500 houses for existing area focussed principally in the City of Milton Keynes, Bletchley and Wolverton with the remaining homes in two sustainable urban extensions to the south-west and south-east of Milton Keynes.

5.3.3 The Halcrow (2000) Drainage Study looked at the impact of future development within the existing DA on fluvial flood risk in Milton Keynes. The study assumed an even distribution of infill expansion with an additional 3000 dwellings in the DA, and found that the infill development had a small to negligible impact on the flows in all the principle water courses. The level of development, 8500 homes, proposed in the core spatial strategy for the existing urban area is nearly three times that assumed in the drainage study, and the cumulative effect of the infill development on flows in principle water courses should be re-examined for this higher level of infill development.

5.3.4 This study was revised in 2003 to update the development scenario through to 2011, and to use FEH hydrological analysis rather than the Flood Studies Report hydrological analysis. The revised study agreed with the conclusions of the original study that the strategic balancing lakes were effective in controlling flood risk up to a 1% AEP, and that development of Milton Keynes up to the 2011 scenario would not increase flood risk in Newport Pagnell. The drainage study did not look at the capacity of the storm water drains, or highway drainage, in Milton Keynes, and as there have been flash floods in the centre these also need to be assessed, to ensure that there is no increase flood risk from this development.

5.3.5 If significant infill development is planned, this should be considered in a Level 2 SFRA, a Surface Water Management Plan or the ongoing Water Cycle Strategy.

5.3.6 The drainage study found that peripheral development would have a much larger impact on flows and hence flood risk, with the greatest effect being on Broughton and Calverton Brook where there are no current methods of flood control and the catchments are small. Water Eaton Brook was not modelled as part of the drainage study; however, similar conclusions are

likely to apply. Any expansion to the southwestwill partly drain into Water Eaton Brook, where there is an existing flooding problem downstream in Bletchley. The Strategic Land Allocation (SLA) will partly drain into Broughton Brook, and Caldecotte Brook which flows through Brown's Wood and Walnut Tree where there is also a history of flooding. The NPPF requires that there is no increase in flood risk downstream of new developments, and suitable SuDS need to be used to ensure that there is no increase in flood risk from these expansion areas.

6 GUIDANCE FOR THE APPLICATION OF THE SEQUENTIAL TEST

6.1 Sequential Approach

6.1.1 The sequential approach is a simple decision-making tool designed to ensure that sites at little or no risk of flooding are developed in preference to sites at higher risk. This will help avoid the development of sites that are inappropriate on flood risk grounds. The subsequent application of the Exception Test where required will ensure that new developments in flood risk areas will only occur where flood risk is clearly outweighed by other sustainability drivers.

6.1.2 The sequential approach can be applied at all levels and scales of the planning process, both between and within Flood Zones. All opportunities to locate new developments (except Water Compatible) in reasonably available areas of little or no flood risk should be explored, prior to any decision to locate them in areas of higher risk.

6.2 Applying the Sequential Test – Plan-Making

6.2.1 A LPA must demonstrate that it has considered a range of possible sites in conjunction with the Flood Zone and vulnerability information from the SFRA and applied the Sequential Test, and where necessary, the Exception Test, in the site allocation process. Figure 6-1 illustrates the approach for applying the Sequential Test that MKC should adopt in the allocation of sites as part of the preparation of the Local Plan. The Sequential Test should be undertaken by MKC and accurately documented to ensure decision processes are consistent and transparent.

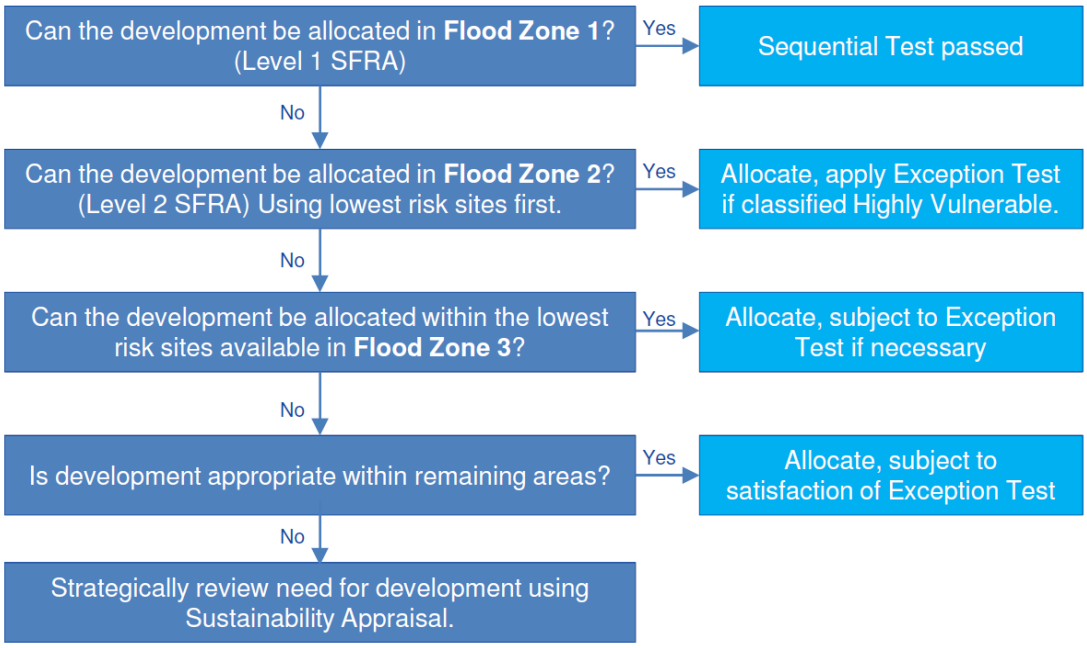

Figure 6-1 Application of Sequential Test for Local Plan preparation

6.2.2 The Sequential Test requires an understanding of the Flood Zones in the Borough and the vulnerability classification of the proposed developments. Flood Zone definitions are provided in Table 4-1 and mapped in the figures in Appendix C (and the Flood Map for Planning (Rivers and Sea) on the Environment Agency website). Flood risk vulnerability classifications, as defined in the NPPG are presented in Table 6-1.

Table 6-1 Flood Risk Vulnerability Classification (NPPG, 2014)

Vulnerability Classification	Development Uses
Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.
Highly Vulnerable	• Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as “essential infrastructure”).
More Vulnerable	• Hospitals. • Residential institutions such as residential care homes, children’s homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	• Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops, financial, professional and other services, restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non–residential institutions not included in “more vulnerable”, and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment works which do not need to remain operational during times of flood. • Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place).
Water-Compatible Development	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities. • MOD defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

6.2.3 NPPF acknowledges that some areas will (also) be at risk of flooding from sources other than fluvial. All sources must be considered when planning for new development including: Flooding from land or surface water runoff; Groundwater; Sewers; and Artificial Sources.

6.2.4 If a location is recorded as having experienced repeated flooding from the same source this should be acknowledged within the Sequential Test.

Table 6-2 Flood Risk Vulnerability and Flood Zone 'Compatibility' (NPPG, 2014)

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

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

6.2.5 The recommended steps in undertaking the Sequential Test are detailed below. This is based on the Flood Zone and Flood Risk Vulnerability and is summarised in Table 6-2.

Recommended stages for LPA application of the Sequential Test in Plan-Making

6.2.6 The information required to address many of these steps is provided in the accompanying GIS layers and maps presented in Appendix B -D.

1. Assign potential developments with a vulnerability classification (Table 6-1). Where development is mixed, the development should be assigned the highest vulnerability class of the developments proposed.
2. The location and identification of potential development should be recorded.
3. The Flood Zone classification of potential development sites should be determined based on a review of the Flood Map for Planning (Rivers and Sea). Where these span more than one Flood Zone, all zones should be noted.
4. The design life of the development should be considered with respect to climate change:
   - 100 years – up to 2115 for residential developments; and
   - Design life for commercial / industrial developments will be variable, however a 75 year design life may be assumed for such development, unless demonstrated otherwise.
5. Identify existing flood defences serving the potential development sites. However, it should be noted that for the purposes of the Sequential Test, Flood Zones ignoring defences should be used.
6. Highly Vulnerable developments to be accommodated within the LPA area should be located in those sites identified as being within Flood Zone 1. If these cannot be located in Flood Zone 1, because the identified sites are unsuitable or there are insufficient sites in Flood Zone 1, sites in Flood Zone 2 can then be considered. If sites in Flood Zone 2 are inadequate then the LPA may have to identify additional sites in Flood Zones 1 or 2

to accommodate development or seek opportunities to locate the development outside their administrative area.

7. Once all Highly Vulnerable developments have been allocated to a development site, the LPA can consider those development types defined as More Vulnerable. In the first instance More Vulnerable development should be located in any unallocated sites in Flood Zone 1. Where these sites are unsuitable or there are insufficient sites remaining, sites in Flood Zone 2 can be considered. If there are insufficient sites in Flood Zone 1 or 2 to accommodate More Vulnerable development, sites in Flood Zone 3a can be considered. More Vulnerable developments in Flood Zone 3a will require application of the Exception Test.
8. Once all More Vulnerable developments have been allocated to a development site, the LPA can consider those development types defined as Less Vulnerable. In the first instance Less Vulnerable development should be located in any remaining unallocated sites in Flood Zone 1, continuing sequentially with Flood Zone 2, then 3a. Less Vulnerable development types are not appropriate in Flood Zone 3b – Functional Floodplain.
9. Essential Infrastructure should be preferentially located in the lowest flood risk zones, however this type of development may be located in Flood Zones 3a and 3b, provided the Exception Test is satisfied.
10. Water Compatible development has the least constraints with respect to flood risk and it is considered appropriate to allocate these sites last. The sequential approach should still be followed in the selection of sites; however it is appreciated that Water Compatible development by nature often relies on access and proximity to water bodies.
11. On completion of the Sequential Test, the LPA may have to consider the risks posed to a site within a Flood Zone in more detail in a Level 2 SFRA. By undertaking the Exception Test, this more detailed study should consider the detailed nature of flood hazard to allow a sequential approach to site allocation within a Flood Zone. Consideration of flood hazard within a Flood Zone would include:
    - flood risk management measures,
    - the rate of flooding,
    - flood water depth,
    - flood water velocity.

6.2.7 Where the development type is Highly Vulnerable, More Vulnerable, Less Vulnerable or Essential Infrastructure and a site is found to be impacted by a recurrent flood source (other than tidal or fluvial), the site and flood sources should be investigated further regardless of any requirement for the Exception Test.

Windfall Sites

6.2.8 Windfall sites are those which have not been specifically identified as available in the Local Plan process. In cases where development cannot be fully met through the provision of site allocations, LPAs are expected to make a realistic allowance for windfall development, based on past trends. It is recommended that the acceptability of windfall applications in flood risk areas should be considered at the strategic level through a policy setting out broad locations and quantities of windfall development that would be acceptable or not in Sequential Test terms.

6.3 Applying the Sequential Test – Planning Applications

6.3.1 As illustrated in Figure 6-2, the flood risk Sequential Test can be considered adequately demonstrated if (1) the Sequential Test has already been carried out for the site for the same

development type at the Local Plan level **and** (2) the development vulnerability is appropriate to the Flood Zone as set out in Table 6-2.

6.3.2 If the answer to either of these two criteria is 'no', then it is necessary to undertake a Sequential Test for the site. The Environment Agency publication 'Demonstrating the flood risk Sequential Test for Planning Applications[24]' sets out the procedure as follows:

- Identify the geographical area of search over which the test is to be applied; this could be the Borough area, or a specific catchment if this is appropriate and justification is provided (e.g. school catchment area or the need for affordable housing within a specific area identified for regeneration in Local Plan policies).
- Identify the source of 'reasonably available' alternative sites; usually drawn from evidence base / background documents produced to inform the Local Plan.
- State the method used for comparing flood risk between sites; for example the Environment Agency Flood Map for Planning, the SFRA mapping, site-specific FRAs if appropriate, other mapping of flood sources.
- Apply the Sequential Test; systematically consider each of the available sites, indicate whether the flood risk is higher or lower than the application site, state whether the alternative option being considered is allocated in the Local Plan, identify the capacity of each alternative site, and detail any constraints to the delivery of the alternative site(s).
- Conclude whether there are any reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed.
- Where necessary, as indicated by Table 6-2, apply the Exception Test.
- Apply the Sequential approach to locating development within the site, as described in Section 5.2.

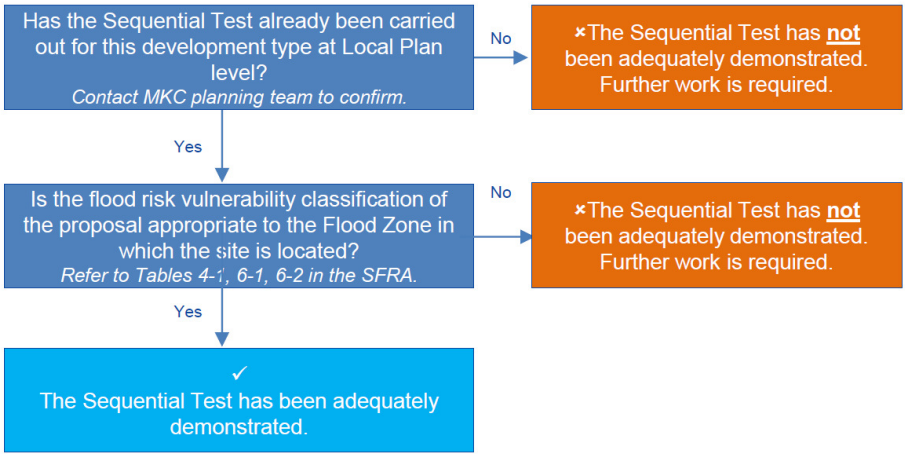

Figure 6-2 Determining when the Sequential Test is required for Planning Applications

6.3.3 It should be noted that it is for LPAs, taking advice from the Environment Agency as appropriate, to consider the extent to which Sequential Test considerations have been satisfied, taking into account the particular circumstances in any given case. The developer should justify with evidence to the LPA what area of search has been used when making the application. Ultimately MKC needs to be satisfied in all cases that the proposed development would be safe and not lead to increased flood risk elsewhere.

[24] Environment Agency, April 2012, 'Demonstrating the flood risk Sequential Test for Planning Applications', Version 3.1

Sequential Test Exemptions

6.3.4 It should be noted that the Sequential Test does not need to be applied in the following circumstances:

- Individual developments proposed on sites which have been allocated in development plans through the Sequential Test.
- Minor development, which is defined in the NPPF as:
  - minor non-residential extensions: industrial / commercial / leisure etc. extensions with a footprint <250m^2.
  - alterations: development that does not increase the size of buildings e.g. alterations to external appearance.
  - householder development: for example; sheds, garages, games rooms etc. within the curtilage of the existing dwelling itself. This definition excludes any proposed development that would create a separate dwelling within the curtilage of the existing dwelling e.g. subdivision of houses into flats.
- Change of Use applications, unless it is for a change of use of land to a caravan, camping or chalet site, or to a mobile home site or park home site.
- Development proposals in Flood Zone 1 (land with a low probability of flooding from rivers or the sea) unless the SFRA, or other more recent information, indicates there may be flooding issues now or in the future (for example, through the impact of climate change).
- Redevelopment of existing properties (e.g. replacement dwellings), provided they:
  - Will not be placed at an unacceptable level of flood risk, irrespective of the risk posed to the existing dwelling;
  - Do not increase the number of dwellings in an area of flood risk (i.e. replacing a single dwelling with an apartment block); and
  - Do not increase the net footprint of the building(s).

6.4 Exception Test

6.4.1 The purpose of the Exception Test is to ensure that new development is only permitted in Flood Zone 2 and 3 where flood risk is clearly outweighed by other sustainability factors and where the development will be safe during its lifetime, considering climate change.

6.4.2 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 the SFRA where one has been prepared; and*
- *A site-specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.*

6.4.3 Both elements of the Exception Test will have to be passed for development to be allocated or permitted.

6.4.4 When determining planning applications, MKC should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where,

informed by a site-specific FRA following the Sequential Test, and if required the Exception Test, it can be demonstrated that:

- within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location, and
- development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of sustainable drainage systems.

6.4.5 There are a number of ways a new development can be made safe:

- Avoiding flood risk by not developing in areas at risk from floods,
- Substituting higher vulnerability land uses for lower vulnerability uses in higher flood risk locations and locating higher vulnerability uses in areas of lower risk on a strategic scale, or on a site basis,
- Providing adequate flood risk management infrastructure which will be maintained for the lifetime of the development, and
- Mitigating the potential impacts of flooding through design and resilient construction.

6.4.6 In order to determine part 1) of the Exception Test, applicants should assess their scheme against the MKC Sustainability Appraisal objectives as set out in the Plan:MK Sustainability Appraisal Scoping Report[25] and reproduced in Table 6-3 overleaf.

6.4.7 In order to demonstrate satisfaction of part 2) of the Exception Test, the measures presented within Sections 5 should be applied and demonstrated within a site-specific FRA as detailed in Section 6.

Table 6-3 Sustainability Objectives (Plan:MK Sustainability Appraisal Scoping Report)

	Sustainability Objective
	Social
1	Ensure that everyone has the opportunity to live in an affordable, sustainably constructed home
2	Protect and improve residents' health and reduce health inequalities
3	Reduce levels of crime and create vibrant communities
4	Reduce the gap between the most deprived areas of Milton Keynes and the average
5	Ensure all sections of the community have good access to services and facilities
6	Improve educational attainment and qualification levels so that everyone can find and stay in work

[25] Plan:MK Sustainability Appraisal Scoping Report (Oct 2014) http://www.milton-keynes.gov.uk/planning-and-building/planning-policy/plan-mk

	Sustainability Objective
	Environmental
7	Combat climate change by reducing levels of carbon dioxide
8	Maintain and improve the air quality in the borough
9	Maintain and improve water quality and minimise the risk of flooding
10	Reduce waste generation and encourage sustainable waste management in accordance with the waste management hierarchy
11	Conserve and enhance the borough's biodiversity
12	Conserve and enhance the borough's heritage and cultural assets
13	Protect and enhance soil quality throughout the borough
14	Limit noise pollution
15	Encourage energy efficiency, renewable energy use and efficient use of natural resources
16	Limit and reduce road congestion and encourage sustainable transportation
17	Ensure the sustainable and efficient use of land by encouraging the development of brownfield sites before greenfield sites
	Economic
18	Ensure high and stable levels of employment
19	Encourage the creation of new businesses
20	Sustain economic growth and enhance competitiveness

Exception Test Exemptions

6.4.8 It is noted that applications for minor development and change of use are exempt from the Exception Test; however site-specific FRAs are still required, as detailed in Section 6.

7 GUIDANCE FOR SITE SPECIFIC FLOOD RISK ASSESSMENTS

7.1 When is a Flood Risk Assessment required?

7.1.1 A site-specific FRA is a report suitable for submission with a planning application which provides an assessment of flood risk to and from a proposed development, and demonstrates how the proposed development will be made safe, will not increase flood risk elsewhere and where possible will reduce flood risk overall in accordance with the NPPF and NPPG.

7.1.2 The NPPF states that a site-specific FRA is required in the following circumstances:

- Proposals for new development (including minor development[26] and change of use) in Flood Zones 2 and 3;
- Proposals for new development (including minor development and change of use) in an area within Flood Zone 1 which has critical drainage problems (as notified to the LPA by the Environment Agency)[27];
- Proposals of 1 hectare or greater in Flood Zone 1; and,
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

7.2 What should a Flood Risk Assessment address?

7.2.1 The NPPG states that site-specific FRAs should always be proportionate to the degree of flood risk and make optimum use of readily available information, for example the mapping presented within this SFRA.

7.2.2 FRAs should also be appropriate to the scale, nature and location of the development. For example, where the development is an extension to an existing house (for which planning permission is required) which would not significantly increase the number of people present in an area at risk of flooding, MKC would generally need a less detailed assessment to be able to reach an informed decision on the planning application. For a new development comprising a greater number of houses in a similar location, or one where the flood risk is greater MKC would need a more detailed assessment.

7.2.3

[26] According to the NPPG, minor development means:
minor non-residential extensions: industrial / commercial / leisure etc. extensions with a footprint <250m^2.
alterations: development that does not increase the size of buildings e.g. alterations to external appearance.
householder development: for example; sheds, garages, games rooms etc. within the curtilage of the existing dwelling itself. This definition excludes any proposed development that would create a separate dwelling within the curtilage of the existing dwelling e.g. subdivision of houses into flats.

[27] Consultation has confirmed that there are no areas with critical drainage problems identified by the Environment Agency.

Table 7-1 presents the different levels of site-specific FRA as defined in the CIRIA publication C624[28] and identifies typical sources of information that can be used.

[28] CIRIA, 2004, Development and flood risk – guidance for the construction industry C624.

Table 7-1 Levels of site-specific Flood Risk Assessment

Description
Level 1 Screening study to identify whether there are any flooding or surface water management issues related to a development site that may warrant further consideration. This should be based on readily available existing information. Typical **sources of information** include: • MKC SFRA • Flood Map for Planning (Rivers and Sea) • Local flood risk policy documentation (such as Flood Risk Management Plan, Catchment Flood Risk Management Plan and Local Flood Risk Management Strategy); • Environment Agency Standing Advice - https://www.gov.uk/flood-risk-assessment-local-planning-authorities • NPPF Tables 1, 2 and 3
Level 2 Scoping study to be undertaken if the Level 1 FRA indicates that the site may lie within an area that is at risk of flooding, or the site may increase flood risk due to increased run-off. This study should confirm the sources of flooding which may affect the site. The study should include: • An appraisal of the availability and adequacy of existing information; • A qualitative appraisal of the flood risk posed to the site, and potential impact of the development on flood risk elsewhere; and • An appraisal of the scope of possible measures to reduce flood risk to acceptable levels. The scoping study may identify that sufficient quantitative information is already available to complete a FRA appropriate to the scale and nature of the development. Typical **sources of information** include those listed above, plus: • Local policy statements or guidance, Local Flood Risk Management Strategy. • Catchment Flood Management Plan. • Data request from the EA to obtain result of existing hydraulic modelling studies relevant to the site and outputs such as maximum flood level, depth and velocity. • Consultation with EA/MKC/sewerage undertakers and other flood risk consultees to gain information and to identify in broad terms, what issues related to flood risk need to be considered including other sources of flooding. • Historic maps. • Interviews with local people and community groups. • Walkover survey to assess potential sources of flooding, likely routes for floodwaters, the key features on the site including flood defences, their condition. • Site survey to determine general ground levels across the site, levels of any formal or informal flood defences
Level 3 Detailed study to be undertaken if a Level 2 FRA concludes that further quantitative analysis is required to assess flood risk issues related to the development site. The study should include: • Quantitative appraisal of the potential flood risk to the development; • Quantitative appraisal of the potential impact of the development site on flood risk elsewhere; • Quantitative demonstration of the effectiveness of any proposed mitigations measures. Typical **sources of information** include those listed above, plus: • Detailed topographical survey. • Detailed hydrographic survey. • Site-specific hydrological and hydraulic modelling studies which should include the effects of the proposed development. • Monitoring to assist with model calibration/verification. • Continued consultation with the LPA, Environment Agency and other flood risk consultees.

Proposed Development in Low Probability Flood Zone 1

7.2.4 FRAs within Flood Zone 1 should primarily take consideration of how the ability of water to soak into the ground may change with development, along with how the proposed layout of development may affect drainage systems. This is to ensure surface water generated by the site is managed in a sustainable manner and does not increase the burden on existing infrastructure and/or flood risk to neighbouring property. Whilst attenuation systems have typically been used to manage surface water in the past, infiltration should be considered and implemented where possible in line with Planning Policy and National Standards (see Section 2 for further detail),The assessment of surface water flood risk should take account for the impact of climate change over the lifetime of the development. SuDS techniques must be employed to ensure there is no increase in flooding elsewhere.

7.2.5 The uFMfSW dataset (Appendix D) should be used to indicate broad areas with a potential surface water flood risk. Figure B8 and B9 should be used to provide an indication of areas where there may be a risk of groundwater flooding and where infiltration SuDS may be viable; however more detailed site investigations will also be required to determine local conditions and suitability of drainage techniques. 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-specific FRA.

Proposed Development within Medium Probability Zone 2

7.2.6 For all sites within Medium Probability Zone 2, a Level 2 Scoping FRA should be prepared based upon readily available existing flooding information, sourced from the Environment Agency, IDB, LLFAs, Canals and Rivers Trust and AWS. If a significant flood risk from other sources (e.g. surface water, groundwater or sewer flooding) is identified then a more detailed FRA should be prepared. It will be necessary to demonstrate that the residual risk of flooding to the property is effectively managed throughout, for example, the provision of raised floor levels and the provision of planned evacuation routes or safe havens. SuDS techniques must be employed to ensure there is no increase in flooding elsewhere.

Proposed Development in Flood Zone 3a High Probability

7.2.7 All FRAs supporting proposed development within High Probability Zone 3a should assess the proposed development against all elements of the Council's flood policy, and 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, the Environment Agency, IDB and AWS 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 design life of the proposed development should be considered with respect to climate change (this is typically 75 years (up to 2090) for commercial / industrial developments; and 100 years (up to 2115) for residential developments).
- For sites within the floodplain of the main rivers applicants should consult the Environment Agency to obtain information on the modelled flood levels associated with these watercourses. Where this information is of suitable quality, modelled flood levels for the relevant annual probability events should be compared with site topographic information to more accurately determine the flood risk to the development site.

- Where the quality and/or quantity of information for any of the flood sources affecting a site is insufficient to enable a robust assessment of the flood risk, further investigation may be required. For example, where hydraulic modelling is not available for ordinary watercourses, the scope of the FRA should be increased to include modelling to ensure details of flooding mechanisms are fully understood and that the proposed development incorporates appropriate mitigation measures.
- 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.
- Opportunities for new developments to deliver reductions to wider flood risk issues where possible, e.g. larger developments may be able to make provisions for flow balancing within new attenuation SuDS features.
- The FRA should consider the vulnerability of those that could occupy and use the development including arrangements for safe access. The FRA should also take account of the vulnerability classification (Table 6-1) and the status of the site in relation to the Sequential and Exception Tests.
- The localised risk of flooding that may occur. This is typically associated with local catchment runoff following intense rainfall.
- 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.
- It is essential that developers thoroughly review the existing and future structural integrity of informal defences, if present, upon which the development will rely (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. This would be particularly important for development that could potentially be affected as a result of a breach of any reservoirs or canals in the study area. SuDS techniques must be employed to ensure no worsening of existing flooding problems elsewhere within the area.
- At all stages, the Local Planning Authority, and where necessary the Environment Agency, IDB and/or the Statutory Water Undertaker should be consulted to ensure the FRA provides the necessary information to fulfil the requirements for Planning Applications.

Proposed Development in Flood Zone 3b Functional Floodplain

7.2.8 In line with the NPPF, development will not normally be allowed in the Functional Floodplain unless it is classified as a 'Water Compatible' or 'Essential Infrastructure' use. Table 2 from the NPPF (refer to Section 6.2 of this report), details the type of developments classified as 'Water Compatible' or 'Essential Infrastructure'.

7.3 Guidance on Flood Risk Management Measures

Sequential approach within development sites

7.3.1 Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development. Most large development proposals include a variety of land uses of varying vulnerability to flooding. The sequential approach should be applied within development sites to locate the most vulnerable elements of a development in the lowest risk areas e.g. residential developments should be restricted to

areas at lower probability of flooding whereas parking, open space or proposed landscaped areas can be placed on lower ground with a higher probability of flooding. Whilst traditionally applied to the risk of river flooding, this approach should also be implemented when considering the risk of surface water flooding across a site.

Finished Floor Levels

7.3.2 Where developing in fluvial flood risk areas is unavoidable, the recommended method of mitigating flood risk to people, particularly with More Vulnerable (residential) land uses, is to ensure internal floor levels are raised a freeboard distance above peak flood water levels. Finished floor levels should be set a minimum of 600mm above the 1% AEP plus climate change peak flood level. The peak flood water level should be derived for the immediate vicinity of the site (i.e. relative to the extent of a site along a watercourse as flood levels are likely to vary with increasing distance downstream) as part of a site-specific FRA.

7.3.3 The Environment Agency's requirements for a freeboard above the peak flood level for finished internal floor levels within Less Vulnerable commercial and industrial units vary, depending upon the proposals. For such land uses, finished internal floor levels may not be required to be raised. However, it is strongly recommended that internal access is provided to upper floors (first floor or a mezzanine level) to provide safe refuge in a flood event. Such refuges will have to be permanent and accessible to all occupants and users of the site.

7.3.4 With respect to residential accommodation and in accordance with Tables 1, 2, and 3 of the NPPG, basement accommodation, single storey accommodation, and multi-storey buildings with ground floor sleeping accommodation should not be permitted, or allocated, in Flood Zone 3. Sleeping accommodation should be restricted to the first floor or above to offer the required 'safe places'. Internal ground floors below this level could however be occupied by either Less Vulnerable commercial premises, garages or non-sleeping residential rooms (e.g. kitchen, study, lounge) (i.e. applying a sequential approach within a building).

7.3.5 Further consultation with the Environment Agency will therefore be required during the undertaking of any detailed FRA. For both Less and More Vulnerable developments where internal access to higher floors is provided, the associated plans showing this should be included within any site-specific FRA.

7.3.6 Hotels are classed as More Vulnerable land uses, however, where it is not be viable to raise finished floor levels, internal access to higher floors must be provided to give safe refuge to all occupants during times of flood. Sleeping accommodation should be set a minimum of 600mm above the 0.1% AEP plus climate change peak flood level.

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

Basement Dwellings

7.3.8 Basement dwellings are classified as Highly Vulnerable and as such they are not permitted within Flood Zone 3a and 3b. They must pass the Sequential and Exception Tests should they be proposed for Flood Zone 2. Basements dwellings should therefore be discouraged within areas at risk of fluvial, surface water or groundwater flooding. Where they are constructed, access must be situated 300mm above the design flood level, and waterproof construction techniques should be employed to avoid seepage during flood events. An

assessment of groundwater conditions will also be required to inform the structural integrity of the basement construction. Similar problems can also occur where excessive surface water ponding occurs close to the sides of buildings, leading to significant infiltration. Surface water flow paths should be assessed to ensure that this does not occur, and to inform the strategic location of SuDS and techniques to route flows around the edge of buildings.

Flood Resistant and Resilient Design

7.3.9 In order to mitigate any potential flood damage, there are a range of flood resilient construction techniques that can be implemented in new developments. The Department for Communities and Local Government (CLG) have published a document *'Improving the Flood Performance of New Buildings, Flood Resilient Construction'*[29], the aim of which is to provide guidance to developers and designers on how to improve the resilience of new properties in low or residual flood risk areas, through the use of suitable materials and construction details. Figure 7-1 provides a summary of different design strategies depending on the depth of floodwater that could be experienced.

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

7.3.11 For flood depths greater than 0.3m, it is likely that structural damage could occur in traditional masonry construction due to excessive water pressures. In these circumstances, the strategy should be to allow water into the building, known as the 'Water Entry Strategy'.

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

[29] CLG (2007) *Improving the Flood Performance of New Buildings, Flood Resilient Construction*

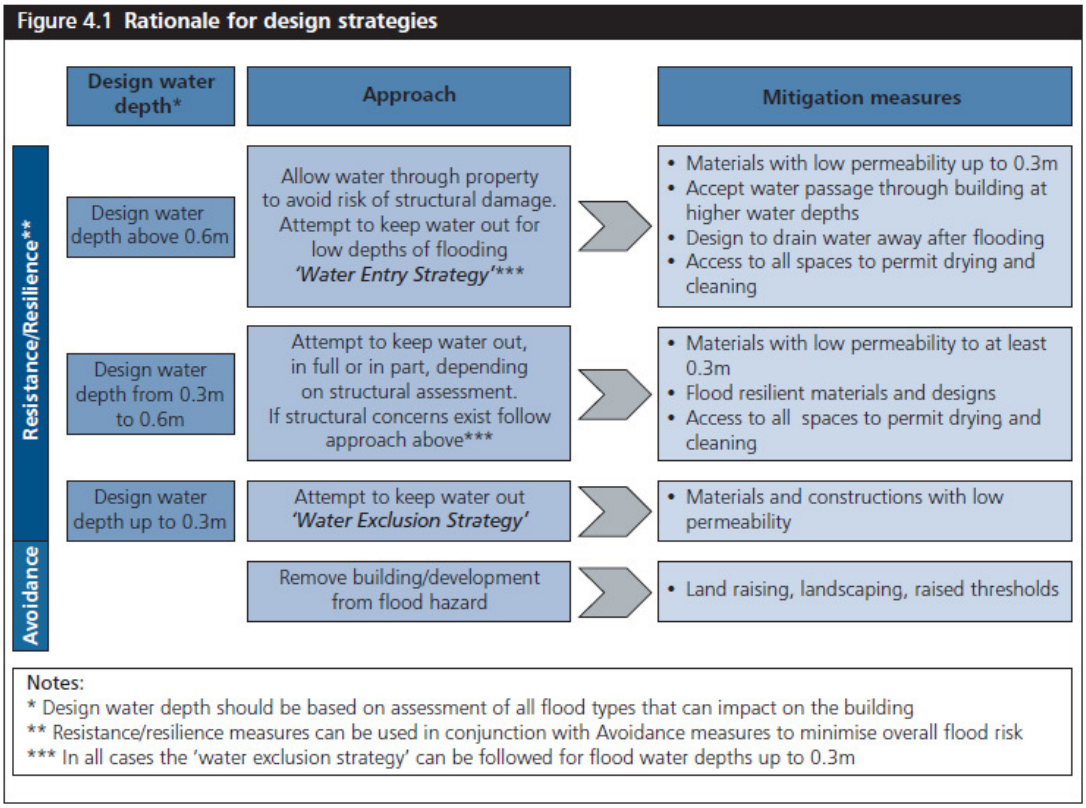

Figure 7-1 Flood Resilient Design Strategies, Improving Flood Performance, CLG 2007

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

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

Structures

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

Safe Access and Egress

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

7.3.17 A safe access/egress route should allow occupants to safely enter and exit the buildings and be able to reach land outside the flooded area using public rights of way without the

intervention of emergency services or others during design flood conditions, including climate change allowances.

7.3.18 For developments located in areas at flood risk the Environment Agency consider 'safe' access/egress to be in accordance with 'FRA Guidance for new Developments FD2320'[30] (Defra and Environment Agency 2005). The requirements for safe access and egress from new developments are as follows in order of preference:

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

Floodplain Compensation Storage

7.3.19 Where proposed development results in an increase in building footprint, the developer must ensure flood risk is not increased elsewhere as a result of the development. Flood risk may be increased elsewhere if the development impacts on the ability of the floodplain to store water.

7.3.20 Where ground levels are elevated to raise the development out of the floodplain, compensatory floodplain storage within areas that currently lie outside the floodplain must be provided to ensure that the total volume of the floodplain storage is not reduced.

7.3.21 Floodplain compensation must be provided on a level for level, volume for volume basis on land which does not already flood and is within the site boundary. Where land is not available within the site boundary, it must be in the immediate vicinity of the site and linked to the planning application. Floodplain compensation should be designed using the 1 in 100 year flood level including an allowance for climate change.

7.3.22 The requirement for no loss of floodplain storage means that it is not possible to modify ground levels on sites which lie completely within the floodplain (when viewed in isolation), as there is no land available for lowering to bring it into the floodplain. It is possible to provide off-site compensation within the local area e.g. on a neighbouring or adjacent site, however, this would be subject to detailed investigations and agreement with the Environment Agency to demonstrate that the proposals would improve and not worsen the existing flooding situation.

Flood routing

7.3.23 Flood risk maybe increase elsewhere if a proposed development alters flow conveyance routes which may include fluvial conveyance routes along floodplains and overland flow pathways. A developer will need to prove that flood conveyance routes are not adversely affected by the development, for example by giving rise to increasing backwater effects or diverting floodwaters onto other properties or areas.

7.3.24 The potential for the exceedance of drainage systems and other flood risk mitigation systems should also be considered during extreme events, with potential overland flow paths being identified and solutions proposed to mitigate surface water flooding.

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

[30] Defra and Environment Agency (2005) Flood Risk Assessment Guidance for New Development FD 2320.

7.3.26 Careful consideration should be given to the use of fences and landscaping walls so as to prevent causing obstruction to flow routes and increasing the risk of flooding to the site or neighbouring areas.

Riverside development

7.3.27 Under Section 109 of the Water Resources Act 1991 and/or Environment Agency Byelaws, any works within 9 metres of any statutory main river (both open channels and culverted sections) requires Environment Agency consent.

7.3.28 In addition, the Environment Agency seek a 9 metre wide undeveloped buffer strip alongside main rivers and behind flood defences, and would also ask developers to explore opportunities for river restoration as part of any development.

7.3.29 As of 6 April 2012 responsibility for the consenting of works by third parties on ordinary watercourses under Section 23 of the Land Drainage Act 1991 (as amended by the Flood and Water Management Act 2010) has transferred from the Environment Agency to MKC as the LLFA. MKC now has responsibility for the consenting of works to ordinary watercourses and has powers to enforce un-consented and non-compliant works. This includes any works (including temporary) that affect flow within the channel of any ordinary watercourse (such as in channel structures or diversion of watercourses). For watercourses within the Drainage District, the Bedford Group of Drainage Boards (BGDB) retain their existing powers.

7.3.30 Consent is refused if the works would result in an increase in flood risk, a prevention of operational access to the watercourse and/ or they pose an unacceptable risk to nature conservation.

Flood Warning and Evacuation Plans

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

7.3.32 For all development proposed in Flood Zone 2 or 3a, a Flood Warning and Evacuation Plan should be prepared to demonstrate what actions site users will take before, during and after a flood event to ensure their safety, and to demonstrate their development will not impact on the ability of the local authority and the emergency services to safeguard the current population.

7.3.33 It may also be necessary to prepare a Flood Warning Evacuation Plan for development in Flood Zone 1 where the area surrounding the site and/or any potential egress routes away from the site may be at risk of flooding during the 1% AEP (1 in 100) flood event including an allowance for climate change.

7.3.34 Flood warning and evacuation plans should include:

- How flood warning is to be provided, such as:
  - availability of existing flood warning systems (Figure B10);
  - where available, rate of onset of flooding and available flood warning time; and
  - how flood warning is given.
- What will be done to protect the development and contents, such as:
  - How easily damaged items (including parked cars) or valuable items (important documents) will be relocated;

- How services can be switched off (gas, electricity, water supplies);
- The use of flood protection products (e.g. flood boards, airbrick covers);
- The availability of staff/occupants/users to respond to a flood warning, including preparing for evacuation, deploying flood barriers across doors etc.; and
- The time taken to respond to a flood warning.

• Ensuring safe occupancy and access to and from the development, such as:

- Occupant awareness of the likely frequency and duration of flood events, and the potential need to evacuate;
- Safe access route to and from the development;
- If necessary, the ability to maintain key services during an event;
- Vulnerability of occupants, and whether rescue by emergency services will be necessary and feasible; and
- Expected time taken to re-establish normal use following a flood event (clean-up times, time to re-establish services etc.)

7.3.35 The Environment Agency has a tool on their website to create a Personal Flood Plan[31]. The Plan comprises a checklist of things to do before, during and after a flood and a place to record important contact details.

7.3.36 There is no statutory requirement for the Environment Agency or the emergency services to approve evacuation plans. The LPA is accountable via planning condition or agreement to ensure that plans are suitable. This should be done in consultation with the local authority emergency planning staff.

[31] Environment Agency Tool 'Make a Flood Plan'. https://www.gov.uk/government/publications/personal-flood-plan

8 GUIDANCE FOR THE APPLICATION OF SUDS

8.1 Introduction

8.1.1 The PPG, which accompanies the NPPF, indicates that priority should be given to the use of SuDS in new developments. Appropriate deployment of SuDS within a development can offer benefits in terms of reductions in flood risk, improvements to water quality, quicker replenishment of groundwater and improved visual amenity.

8.1.2 SuDS are typically softer engineering solutions inspired by natural drainage processes, such as ponds and swales, which manage water as close to its source as possible. Wherever possible, a SuDS technique should seek to contribute to each of the three goals identified below with the preferred system contributing significantly to each objective. Where possible SuDS solutions for a site should seek to:

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

8.1.3 These goals can be achieved by utilising a management plan incorporating a chain of techniques, as outlined in Interim Code of Practice for Sustainable Drainage Systems[32], where each component adds to the performance of the whole system:

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

8.1.4 The application of SuDS is not limited to a single technique per site. Often a successful SuDS solution will utilise a combination of techniques, providing flood risk, pollution and landscape/wildlife benefits as shown by Milton Keynes' unique surface water management network of balancing lakes etc. In addition, SuDS can be employed on a strategic scale, for example with a number of sites contributing to large scale jointly funded and managed SuDS. It should be noted, each development site must offset its own increase in runoff and attenuation cannot be "traded" between developments.

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

- **Infiltration**: the soaking of water into the ground. This is the most desirable solution as it mimics the natural hydrological process. The rate of infiltration will vary with soil type and condition, the antecedent conditions and with time. The process can be used to recharge groundwater sources and feed baseflow of local watercourses, but where groundwater sources are vulnerable or there is risk of contamination, infiltration techniques are not suitable.

[32] National SuDS Working Group (2004) Interim Code of Practice for Sustainable Drainage Systems

- **Attenuation**: the slowing down of surface flows before their transfer downstream, usually achieved by creating a storage volume and a constrained outlet. In general, though the storage will enable a reduction in the peak rate of runoff, the total volume will remain the same, just occurring over a longer duration.
- **Conveyance:** the transfer of surface runoff from one place to another, e.g. through open channels, pipes and trenches.
- **Water Harvesting:** the direct capture and use of runoff on site, e.g. for domestic use (flushing toilets) or irrigation of urban landscapes. The ability of these systems to perform a flood risk management function will be dependent on their scale, and whether there will be a suitable amount of storage always available in the event of a flood.

8.1.6 As aforementioned, MKC's Drainage Strategy aims to guide developers on the following aspects related to drainage and flood risk throughout Milton Keynes Borough:

- Fluvial Flood Zones and risks and the constraints imposed upon development;
- What strategic measures are required to facilitate further development and how these measures may occur in conjunction with localised measures such as SuDS; and,
- Considerations relating to conservation and amenity, funding and securing reliable, long-term maintenance.

8.1.7 Specifically relating to SuDS, the guidance promotes the utilisation of sustainable drainage where applicable and highlights how they can be used to overcome issues associated with conventional drainage systems. The SPG demonstrates how SuDS can be used throughout Milton Keynes alongside other surface water management infrastructure such as balancing lakes to develop blue infrastructure which derives multiple benefits relating to amenity, nature conservation, water quality etc.

8.1.8 As part of any SuDS scheme, consideration should be given to the long-term maintenance of the SuDS to ensure that it remains functional for the lifetime of the development.

Table 8-1 has been reproduced from the SuDS Manual, CIRIA C697 and outlines typical SuDS techniques.

*Table 8-1 Typical SuDS Components (Y = primary process * = some opportunities subject to design)*

Technique	Description	Conveyance	Detention	Infiltration	Harvesting
Pervious Surfaces	Pervious surfaces allow rainwater to infiltrate through the surface into an underlying storage layer, where water is stored before infiltration to the ground, reuse, or release to surface water.		Y	Y	*
Filter Drains	Linear drains/trenches filled with a permeable material, often with perforated pipe in the base of the trench. Surface water from the edge of paved areas flows into the trenches, is filtered and conveyed to other parts of the site.	Y	Y		
Filter Strips	Vegetated strips of gently sloping ground designed to drain water evenly from impermeable areas and filter out silt and particulates.	*	*	*	
Swales	Shallow vegetated channels that conduct and/or retain water, and can permit infiltration when unlined.	Y	Y	*	
Ponds	Depressions used for storing and treating water.		Y	*	Y
Wetlands	As ponds, but the runoff flows slowly but continuously through aquatic vegetation that attenuates and filters the flow. Shallower than ponds. Based on geology these measures can also incorporate some degree of infiltration.	*	Y	*	Y
Detention Basin	Dry depressions designed to store water for a specified retention time.		Y		
Soakaways	Sub-surface structures that store and dispose of water via infiltration.			Y	
Infiltration Trenches	As filter drains, but allowing infiltration through trench base and sides.	*	Y	Y	
Infiltration Basins	Depressions that store and dispose of water via infiltration.		Y	Y	
Green Roofs	Green roofs are systems which cover a building's roof with vegetation. They are laid over a drainage layer, with other layers providing protection, waterproofing and insulation. It is noted that the use of brown/green roofs should be for betterment purposes and not to be counted towards the provision of on-site storage for surface water. This is because the hydraulic performance during extreme events is similar to a standard roof (CIRIA C697).		Y		
Rainwater Harvesting	Storage and use of rainwater for non-potable uses within a building, e.g. toilet flushing. It is noted that storage in these types of systems is not usually considered to count towards the provision of on-site storage for surface water balancing because, given the sporadic nature of the use of harvested water, it cannot be guaranteed that the tanks are available to provide sufficient attenuation for the storm event.	*	*	*	Y

8.1.9 There are a number of SuDS managed in Milton Keynes, as detailed in Table 8-2.

Table 8-2 SuDS in Milton Keynes

Location	Grid Reference	Summary details
Bradwell Lake	SP8325242588	Built in 1972. Overtops at time of high flows. DW looked at changes to high level outlet in 1979. Designed on basis of 100% and 70% run off.
Brooklands: Brooklands Meadows Linear Park (transfer to The Parks Trust is imminent).	SP89840240204	Surface water attenuation reservoir within the Linear Park (management agreement with the Internal Drainage Board).
Broughton: Ferry Meadows/Pye Bridge End residential development, Broughton	SP8914139786 (centre of development)	Small system of swales and ponds taking surface water from adjoining roads and car parks.
Broughton: Broughton Brook Linear Park between Tanfield Lane & Milton Road	SP8949839554 (centre of development)	Various swales/surface water attenuation basins located along the linear park.
Broughton: Ulverston Crescent	SP89488439068	Large swale attenuating flows to the Broughton Brook.
Broughton Gate/Broughton Brook Linear Park	SP8988739321 & SP9027838929	Two surface water attenuation ponds located in the Linear Park, both controlled by Hydrobrake chambers (outflow to Broughton Brook).
Caldecotte	SP8902435172	Operation of control gates depends on flow increased upstream of the DA and downstream of Willen Lake. Flow in Broughton Brook also monitored.
Furzton	SP8471835949	Built after 1982. Design discharge determined to control flows downstream.
Kingsmead South residential development)	SP8234333856 (centre of development)	Swales and attenuation pond (system installed in advance of construction of surrounding residential development plots).
Lodge Lake	SP8313738391	Built in 1981. This was constructed to provide short term storage as a flood meadow. Necessary to deal with high flows arising from increased developed areas. Designed on basis of 100% and 70% run off.
Loughton (Tear Drop Lakes)	SP8471137109	Built in 1977. Designed on basis of 100% and 70% run off.
Magna Park commercial warehouse development (under construction)	SP9166438602 (centre of development)	Swales and attenuation ponds/lake providing the surface water management system for the estate and adjacent highways attenuating flow rates to the Broughton Brook (some parts complete/some parts undergoing construction).
Oxley Park east	SP8218035220 (centre of development)	Network of swales and ponds taking surface water from roads, driveways and roofs in the residential development. Includes underground chambers to control flow rates between ponds.
Shenley Wood	SP8262635802 (centre of	Network of swales and ponds taking surface water from roads, driveways and roofs in the mixed commercial/residential (retirement

Location	Grid Reference	Summary details
	development)	village) development.
Simpson	SP8765635900	Also known as Ashlands. Built prior to 1977. Operates on similar basis to Loughton.
Tattenhoe Park	SP256533265	Network of swales and ponds taking surface water from roads, driveways and roofs in the residential development (undergoing construction). Includes underground chambers to control outflow rates to the Loughton Brook.
Tongwell	SP8683142346	Designed in 1973. Peak inflow is 38 cumecs. Peak outflow is 1.42 cumecs.
Westcroft: Mapperton Close/Frampton Grove	SP8257934321	Swales and attenuation ponds within residential development.
Willen	SP8800840244	Completed in 1977. Operation of control gates depends on flow increased upstream of the DA and downstream of Willen Lake. Flow in Broughton Brook also monitored.

8.1.10 For further guidance on SuDS, the following documents and websites are recommended as a starting point:

- http://www.susdrain.org/
- Defra Non-statutory technical standards for SuDS (March 2015)[33];
- The NPPF and the associated NPPG.
- The SuDS Manual – CIRIA C697 (2007) provides the best practice guidance on the planning, design, construction, operation and maintenance of Sustainable Drainage Systems and facilitates their effective implementation within developments.
- CIRIA C644 – Green Roofs (2007) provides guidance on the design, construction and operation of Green Roofs. The guidance also describes how 'quick wins' for biodiversity can be achieved in the built environment by incorporating nesting and roosting boxes for bird, bats and other animals.
- Interim Code of Practice for Sustainable Drainage Systems, National SuDS Working Group, 2004.
- Defra / Environment Agency Preliminary Rainfall Runoff Management Rev E[34] provides guidance on surface water drainage strategy for the Environment Agency, LPAs and developers.

8.2 Use of Infiltration SuDS in Milton Keynes

8.2.1 As part of this SFRA, an assessment of the suitability of using infiltration SuDS techniques across the Borough has been undertaken. The BGS infiltration SuDS suitability map shown on Figure B9 is largely based on the BGS infiltration SuDS suitability dataset. It is understood from the BGS guidance notes that the dataset is derived from the following data:

- Infiltration constraints summary layer;
- Superficial deposits permeability;
- Superficial deposits thickness;

[33] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf
[34] Defra / Environment Agency (2013) Rainfall runoff management for developments

- Bedrock permeability;
- Depth to groundwater level; and
- Geological indicators of flooding

8.2.2 Four categories have been identified by the BGS for suitability for Infiltration SuDS:

- Highly compatible for Infiltration SuDS: The subsurface is likely to be suitable for free-draining infiltration SuDS.
- Probably compatible for Infiltration SuDS: The subsurface is probably suitable for infiltration SuDS although the design may be influenced by the ground conditions.
- Opportunities for bespoke infiltration SuDS: The subsurface is potentially suitable for infiltration SuDS although the design will be influenced by the ground conditions.
- Very significant constraints are indicated: There is a very significant potential for one or more geohazards associated with infiltration.

8.2.3 The infiltration SuDS suitability assessment shown on Figure B9 is based on the map produced by the BGS.

8.2.4 The more rural areas to the north of Milton Keynes city centre have mostly been designated as 'probably compatible for infiltration SuDS'. This is due to the comparatively higher permeability of the underlying limestone geology.

8.2.5 In the east of the Borough, 'opportunities for bespoke SuDS' have been identified. This is due to the underlying geology being relatively impermeable Oxford Clay. Conventional SuDS may be restricted, i.e. probably unsuitable where high infiltration rates are required, although there may exist potential for lower infiltration rate SuDS in conjunction with attenuation SuDS.

8.2.6 In the south and west of the borough there is greater variFation with patches of highly compatible areas, and a mixture of probably compatible and opportunities for bespoke SuDS. Further site investigation is required to confirm local conditions and confirm depth to water table.

8.2.7 In the far south-eastern corner of the Borough there is an area which has been delineated as 'Highly compatible for Infiltration SuDS'. This coincides with the Woburn Sands Formation a principal aquifer with a high permeability. However as this area being classified as within a SPZ there may be restrictions on the application of SuDS.

8.2.8 In addition, the area along and adjacent to watercourses throughout the Borough indicates that there are very significant constraints. This is due to the high risk of river and ground water flooding in these areas as seen in Figures B5 and B8 respectively.

8.2.9 Overall Figure B9 shows that across the Milton Keynes Borough there are areas which are considered highly compatible, however in general the north is considered probably compatible whereas the central and south of the borough it has been identified as opportunities for bespoke infiltration SuDS.

8.2.10 It should be noted that this is a high level assessment and only forms an approximate guide to infiltration SuDS suitability; an enhanced site investigation is required in all cases to confirm local conditions. The maximum likely groundwater levels should be assessed, to confirm that soakaways will continue to function even during prolonged wet conditions.

8.2.11 In addition, any proposed infiltration SuDS should be located away from areas of historic landfill, known contamination or areas which are at risk of contamination. This is to ensure that that the drainage does not re-mobilise latent contamination and exacerbate the risk to

groundwater quality and down gradient receptors such as abstractors, springs and rivers. In such circumstances, a preliminary groundwater risk assessment may be required with the planning application.

8.3 National SuDS Standards

8.3.1 A set of National Standards have been published (currently in draft form) which set the requirements for the design, construction, maintenance and operation of sustainable drainage systems (SuDS) in accordance with paragraph 5 of Schedule 3 (National Standards) of the Flood and Water Management Act 2010.

8.3.2 The National Standards that are of chief concern in relation to the consideration of flood risk to and from development relating to runoff destinations, peak flow control and volume control are presented below:

Peak Flow Control

8.3.3 *SuDS NS2 'For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must not exceed the peak greenfield runoff rate for the same event'.*

8.3.4 *SuDS NS3 'For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event'.*

Volume Control

8.3.5 *SuDS NS4 'Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the greenfield runoff volume for the same event'.*

8.3.6 *SuDS NS5 'Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event'.*

8.3.7 *SuDS NS6 'Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with SuDS NS4 or SuDS NS5 above, the runoff volume must be discharged at a rate that does not adversely affect flood risk'.*

Flood Risk within the Development

8.3.8 *SuDS NS7 'The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event'.*

8.3.9 *SuDS NS8 'The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development'.*

8.3.10 *SuDS NS9 'The design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that minimise the risks to people and property'.*

9 SUMMARY AND RECOMMENDATIONS

9.1 Site Allocation Process

9.1.1 The outputs from this Level 1 SFRA should be used as an evidence base from which to direct new development to areas of low flood risk (Flood Zone 1). Where development cannot be located in Flood Zone 1, the Council should use the flood maps to apply the Sequential Test to their remaining land use allocations.

9.1.2 Where the need to apply the Exception Test is identified, due to there being an insufficient number of suitable sites for development within zones of lower flood risk, the scope of the SFRA may need to be widened to a Level 2 assessment. The need for a Level 2 SFRA cannot be fully determined until the Council has applied the Sequential Test. It is recommended that as soon as the need for the Exception Test is established, a Level 2 SFRA is undertaken by a suitably qualified technical expert or engineer so as to provide timely input to the overall Plan Making process.

9.2 Council Policy

9.2.1 Milton Keynes' Drainage SPG is to be reviewed in order to reflect changes to National Planning Policy in which came into effect in April 2015. The SPG will continue to be a resource for the effective implementation of SuDS throughout Milton Keyes where appropriate and will endeavour to deliver multiple benefits where practicable.

9.2.2 The Local Plan for Milton Keynes (PlanMK) and supporting guidance documents should continue to include policies to:

- Protect the functional floodplain from development;
- Direct vulnerable development away from flood affected areas;
- Ensure all new development is 'safe', meaning that dry pedestrian access to and from the development is possible without passing through the 1 in 100 year plus climate change floodplain, and emergency vehicular access is possible; and

9.2.3 Promote the use of strategic, integrated and maintainable SuDS in all Flood Zones for both Brownfield and Greenfield sites. Space should be set-aside for SuDS.

Emergency Planning

9.2.4 It is recommended that the Council's Emergency Response Plans are reviewed and updated in light of the findings of the SFRA to ensure that safe evacuation and access for emergency services is possible during times of flood both for existing developments and those being promoted as possible sites within the Plan Making process. It is further recommended that the Council works with the Environment Agency to promote the awareness of flood risk and encourage communities at risk to sign-up to the Environment Agency Flood Warning Service.

9.3 Future Updates to the SFRA

9.3.1 This SFRA has been updated building heavily upon existing knowledge with respect to flood risk within the Borough. The Environment Agency review and update the Flood Map for Planning (Rivers and Sea) on a quarterly basis and a rolling programme of detailed flood risk mapping is underway. Future new modelling of watercourses in the area will improve the current knowledge of flood risk within the Borough, and may marginally alter predicted flood extents within parts of the Borough in the future.

9.3.2 New information may influence future development control decisions within these areas. Therefore it is important that the SFRA is adopted as a 'living' document and is reviewed

regularly in light of emerging policy directives, flood risk datasets and an improving understanding of flood risk within the Borough.

9.3.3 There is little data available on flooding from smaller watercourses in Milton Keynes. However the list of historic flooding incidents also shows several incidences of flooding from smaller watercourses from blocked culverts or insufficient culvert capacity. The Council should consider recording and analysing their responses to flooding incidents to ensure that recurring problems such as blocked culverts and drains are identified.

9.4 Level 2 SFRA

9.4.1 This Level 1 SFRA will allow the MKC to assess their proposed site allocations using the Sequential Test. This will act as a 'sieving' process, allocating as many sites as possible to Flood Zone 1. Where it is found that some sites can only be placed in Flood Zones 2 and 3, the Exception Test will need to be applied as described in Section 6, and Council may wish to consider the preparation of a Level 2 SFRA.

9.4.2 A Level 2 SFRA should be viewed as rather more site specific than a Level 1 SFRA, addressing flood risk to potential development sites which have gone through the Sequential Test and have been located in Flood Zones 2 or 3. The data required for a Level 2 SFRA will therefore depend upon which, if any, of the council's final list of preferred sites remain in Flood Zones 2 and 3 following application of the Sequential Test and hence where the Exception Test needs to be applied.

9.4.3 It is important that a Level 2 SFRA considers the variation of flood risk within a Flood Zone due to flood risk management measures i.e. flood defences. This increased scope involves a more detailed review of flood hazard (flood probability, flood depth, flood velocity, rate of onset of flooding). If development is to be located behind defences, or downstream of flood storage reservoirs, it may be necessary to model constructional failure of the defence (breach) and water levels rising to exceed the level of the defence (overtopping). It is not necessary to carry out such scenarios behind all existing defences, if no new development is to be located behind these structures. In some instances improvements to existing flood defences may be required to manage residual flood risks. Here, the SFRA should include an appraisal of the extent of works to provide or raise the flood defence to appropriate standard.

9.4.4 Level 2 SFRA outputs typically include:

- Maps showing distribution of flood hazard (as a function of flood depth and velocity) within Flood Zones;
- Guidance on appropriate policies for the development of sites which satisfy the Exception Test i.e. are safe for occupants / users over their lifetime, do not increase flood risk and where possible reduce flood risk overall;
- Guidance on the preparation of FRAs for sites with varying flood risk across the Flood Zone.

APPENDIX A DATA REGISTER

The following register details the datasets that were used throughout the preparation of the Level 1 SFRA update.

	Dataset	Source	Format	Description
Fluvial	Flood Map for Planning (Rivers and Sea) Flood Zones 2 and 3	Environment Agency Geostore* (*available to the public on the Environment Agency website)	GIS Layer	A quick and easy reference that can be used as an indication of the probability of flooding from main rivers. The original Flood Map was broad scale national mapping typically using JFLOW modelling software that is generally thought to have inaccuracies. This is regularly updated with the result of new modelling studies. For those rivers where there is no updated modelling (River Rythe), the Flood Zones from JFLOW modelling may not provide an accurate representation of probability of flooding. Typically watercourses with a catchment area less than 3km^2 are omitted from Environment Agency mapping unless there is a history of flooding affecting a population. Consequently there will be some locations adjacent to watercourses that on first inspection, suggest there is no flood risk.
	Detailed River Network (DRN)	Environment Agency Geostore	GIS Layer	Identification of the river network including main rivers and ordinary Watercourses for which the Environment Agency, MKC and BGDB have discretionary and regulatory powers.
	IDB Watercourses	Bedford Group of Drainage Boards	GIS Layer	GIS layer of the Bedford Group of Drainage Board District. GIS layer of the arterial watercourses on which the Boards have powers to undertake works.
	Historic Flood Map	Environment Agency Geostore	GIS Layer	A single GIS layer showing the extent of fluvial historic flood events created using best available information at time of publication. However, some of the data is based on circumstantial and subjective evidence. There is not always available metadata, e.g. date of flood event.
	Modelled flood outlines for Upper River Great Ouse	Environment Agency	GIS Layer	Detailed and calibrated hydraulic model outlines that have been mapped using LiDAR (1m and 2m resolution). The Environment Agency applies the outcomes from these detailed modelling studies to update the Flood Map for Planning (Rivers and Sea) on a quarterly basis.
	Modelled flood outlines for Middle Great Ouse	Environment Agency	GIS Layer	Some watercourses have not been modelled (e.g. smaller tributaries). The flood risk from these is based on broad scale JFLOW modelling and therefore the flood risk from these cannot be as accurately assessed.
	Asset Information Management System (AIMS) for the Borough	Environment Agency	GIS Layer	Shows where there are existing defences, structures, heights, type and design standard. However many fields contain default values.
	Fluvial Flood Records	Environment Agency	MS Access database	Historic records of fluvial flooding in the Borough held by the Environment Agency.
	Fluvial Flood Records	BGDB	GIS layer	Records of flooding associated with the arterial watercourses within the Bedford Group of Drainage Board District.
	Fluvial Flood Records	MKC	Existing reports	Accounts of flood events that have occurred across the Borough and which may therefore be susceptible to flooding in the future without intervention.

	Dataset	Source	Format	Description
Surface Water	'Updated Flood Map for Surface Water' dataset	Environment Agency Geostore	GIS Layer	Provides an indication of the broad areas likely to be at risk of surface water flooding, i.e. areas where surface water would be expected to flow or pond. This dataset does not show the susceptibility of individual properties to surface water flooding.
	IDB Watercourses	Bedford Group of Drainage Boards	GIS Layer	GIS layer of the Bedford Group of Drainage Board District. GIS layer of the arterial watercourses on which the Boards have powers to undertake works.
	Surface Water Flood Records	MKC	Existing reports	Accounts of flood events that have occurred across the Borough and which may therefore be susceptible to flooding in the future without intervention.
	Surface Water Flood Records	Highways Agency	.csv file	Records of flooding (XY coordinates), standing water and ponding on the Highways Agency network from their command and control system.
Groundwater	GIS layers of the geology across the borough	MKC	GIS Layer	Illustrates bedrock and superficial geology across the Borough.
	Groundwater Vulnerability Classifications	Environment Agency Geostore	GIS Layer	Broadly shows extents of aquifers in the Borough. Where aquifers are highly vulnerable, they often have a more permeable covering and, together with dry valley and watercourse networks, potential groundwater flooding areas can be identified. Dataset used in assessment described in Sec 3.5.
	GIS layer of Source Protection Zones	Environment Agency Geostore	GIS Layer	Shows the areas where the groundwater is protected by the Environment Agency. The designation may not consider fractures in the strata at a greater radius where pollutants could reach the source protection zone.
	Aquifer Designation Maps for Bedrock and Superficial	Environment Agency Geostore	GIS Layer	A polygon shapefile that shows aquifer designations for bedrock aquifers. The designations identify the potential of the geological strata to provide water that can be abstracted and have been defined through the assessment of the underlying geology.
	GIS layer of bedrock and superficial geology	British Geological Survey	GIS Layer	A polygon shapefile that shows aquifer designations for superficial aquifers. The designations identify the potential of the geological strata to provide water that can be abstracted and have been defined through the assessment of the underlying geology.
	GIS layer 'Infiltration SuDS Map'	British Geological Survey	GIS Layer	Dataset produced by the BGS of relevance to professionals who make decisions on SuDS design, construction and approval. The maps will help: (1) make preliminary decisions on the suitability of the subsurface for infiltration SuDS; (2) make preliminary decisions on the type of infiltration SuDS that will likely be appropriate; (3) assess SuDS planning applications to determine whether the necessary factors have been considered; and (4) determine whether infiltration SuDS could be appropriate where a non-infiltrating SuDS technique has been proposed.
	GIS layer 'Susceptibility to Groundwater Flooding'	British Geological Survey	GIS Layer	Dataset produced by BGS showing areas susceptible to groundwater flooding on the basis of geological and hydrogeological conditions. Suitable for broad scale assessment such as the SFRA.
Sewer	DG5 Register of sewer flooding incidents, by post code area.	Anglian Water	MS Word Doc	Indicates post code areas that may be prone to flooding as have experienced flooding in the last 10 years due to hydraulic incapacity. However, given that AW target these areas for maintenance and improvements, areas that experienced flooding in the past may no longer be at greatest risk of flooding.

	Dataset	Source	Format	Description
Other	LiDAR data (DTM, ASCII)	Environment Agency Geomatics Group	GIS ASCII	Provides a useful basis for understanding local topography and the surface water flood risk in the area. Spatial resolution of 1m. Accuracy of +/- 0.25m. The Environment Agency's LiDAR data archive contains digital elevation data derived from surveys carried out since 1998.
Emergency Planning	Flood Warning Areas	Environment Agency Geostore	GIS Layer	Indicates which areas are covered by the flood warning system.
Planning	OS Mapping of MKC administrative area (1:10K, 1:25K)	OS via MKC	GIS format	Provides background mapping to other GIS layers. Designed for use at 1:25K and 1:10K scales.
	GIS layer of administrative boundary	MKC	GIS Layer	Defines the administrative area of the Borough for mapping purposes.
	GIS layer of post code boundaries	MKC	GIS Layer	Delineates post code boundaries for the Borough. Enables mapping of Anglian Water datasets which are provided by post code sector.

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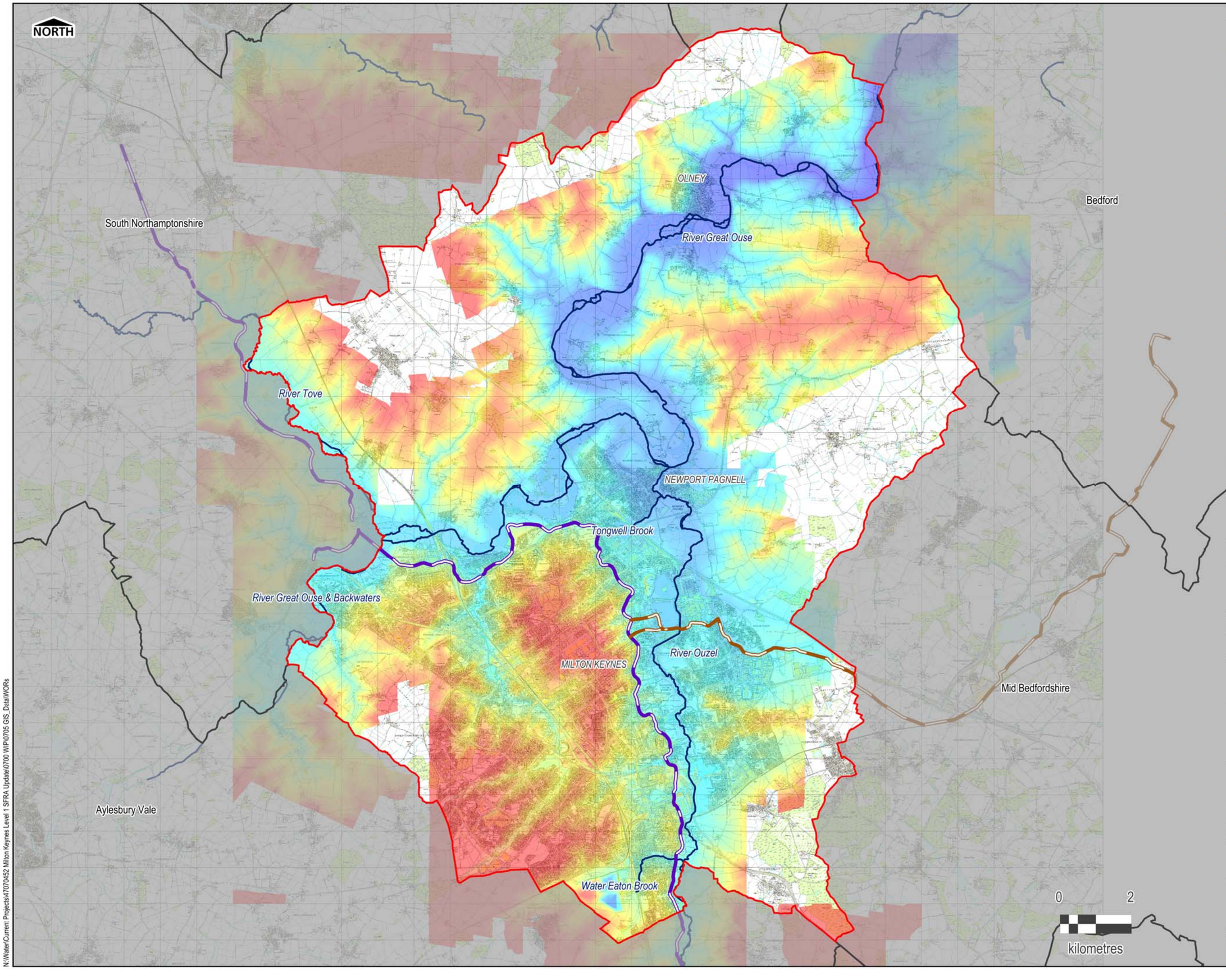
APPENDIX B STUDY AREA MAPPING



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LEGEND

- Milton Keynes Council Boundary
- Local Planning Authority Boundary
- Main Rivers
- Grand Union Canal
- Milton Keynes to Bedford Canal

Topography (m AOD)

- < 45m
- 65m
- 75m
- 85m
- 95m
- > 105m

Notes

Light Detection and Ranging (LIDAR) is an airborne mapping technique, which uses a laser to measure the distance between the aircraft and the ground.
This dataset has a spatial resolution of 1m. The Environment Agency's LIDAR data archive contains digital elevation data derived from surveys carried out since 1998.
The Environment Agency typically fly LIDAR along the river corridors and this accounts for the missing coverage over parts of the study area.

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: MILTON KEYNES COUNCIL

Project Title: MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: LIDAR TOPOGRAPHIC SURVEY

Drawn	Checked	Approved	Date
SL	EG	JR	07/08/2014

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Drawing Number: FIGURE B1
Rev: 1

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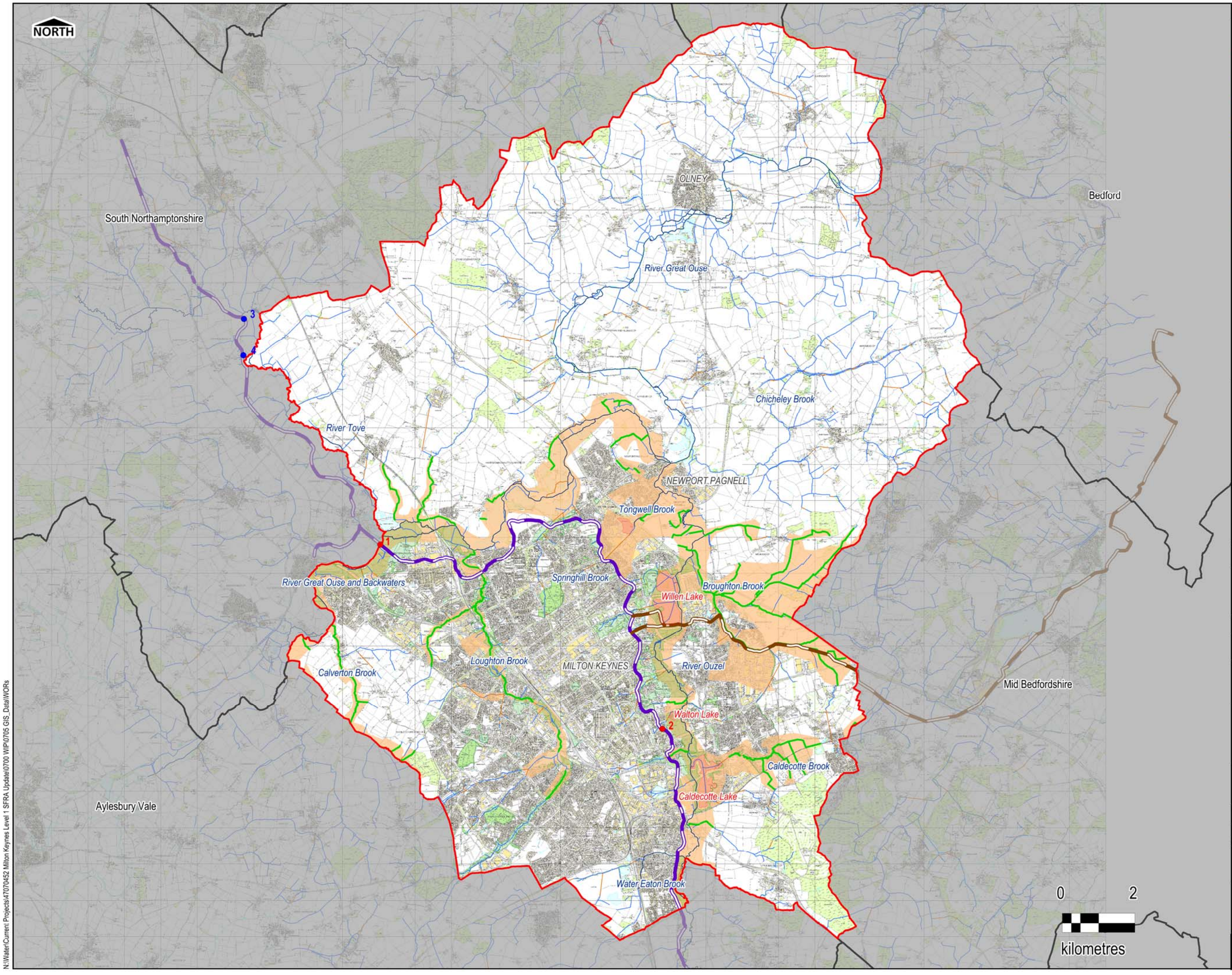

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LEGEND

- Milton Keynes Council Boundary
- Local Planning Authority Boundary
- Main Rivers
- Ordinary Watercourses (Surface Level)
- Ordinary Watercourses (Culverted)
- Drainage Board designated watercourses
- Grand Union Canal
- Milton Keynes to Bedford Canal
- Flood Storage Area
- Drainage Board District
- Linear Parks
- Breach Incidents (Canal and River Trust)
- Overtopping Incidents (Canal and River Trust)

Notes

Main Rivers are designated by Defra on a 'Main River Map'. The Environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for Main Rivers only. However overall responsibility for maintenance lies with the riparian owner.

An Ordinary Watercourse is a watercourse that does not form part of a Main River. This includes all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows according to the Land Drainage Act 1991.

Drainage Boards have powers under the Land Drainage Act 1991 (as amended by the 1994 Act) to undertake works on any watercourse within their district other than Main River. A Board's District is defined on a sealed map prepared by the Environment Agency and approved by the relevant Ministry. In addition Boards can undertake works on watercourses outside their drainage district in order to benefit the district. Within the Drainage Districts, Boards have designated arterial watercourses to which they will normally apply their statutory powers.

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: MILTON KEYNES COUNCIL

Project Title: MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: WATERCOURSES AND WATER BODIES

Drawn	Checked	Approved	Date
SL	EG	JR	07/08/2014

URS Internal Project No.: 47070452

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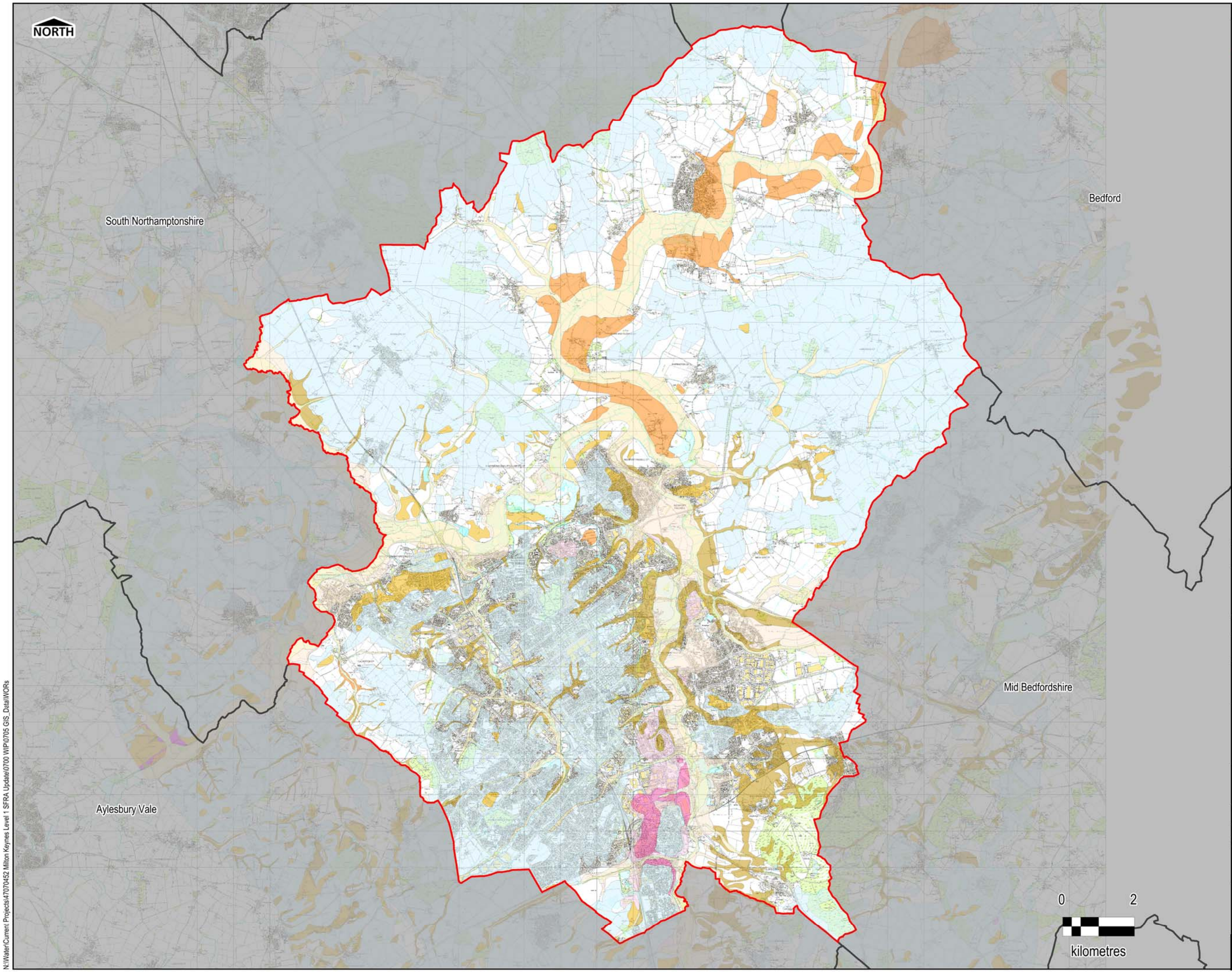

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LEGEND

- Milton Keynes Council Boundary
- Local Planning Authority Boundary

Superficial Geology

- ALLUVIUM
- GLACIOFLUVIAL DEPOSITS
- GLACIOLACUSTRINE DEPOSITS
- HEAD
- PEAT
- RIVER TERRACE DEPOSITS
- SAND AND GRAVEL (UNDIFFERENTIATED)
- TILL

Notes

The 1:50,000 scale digital map data is generalised and the geological interpretation should be used only as a guide to the geology at a local level, not as a site-specific geological plan based on detailed site investigations.

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: MILTON KEYNES COUNCIL

Project Title: MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: SUPERFICIAL GEOLOGY

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FIGURE B3	1

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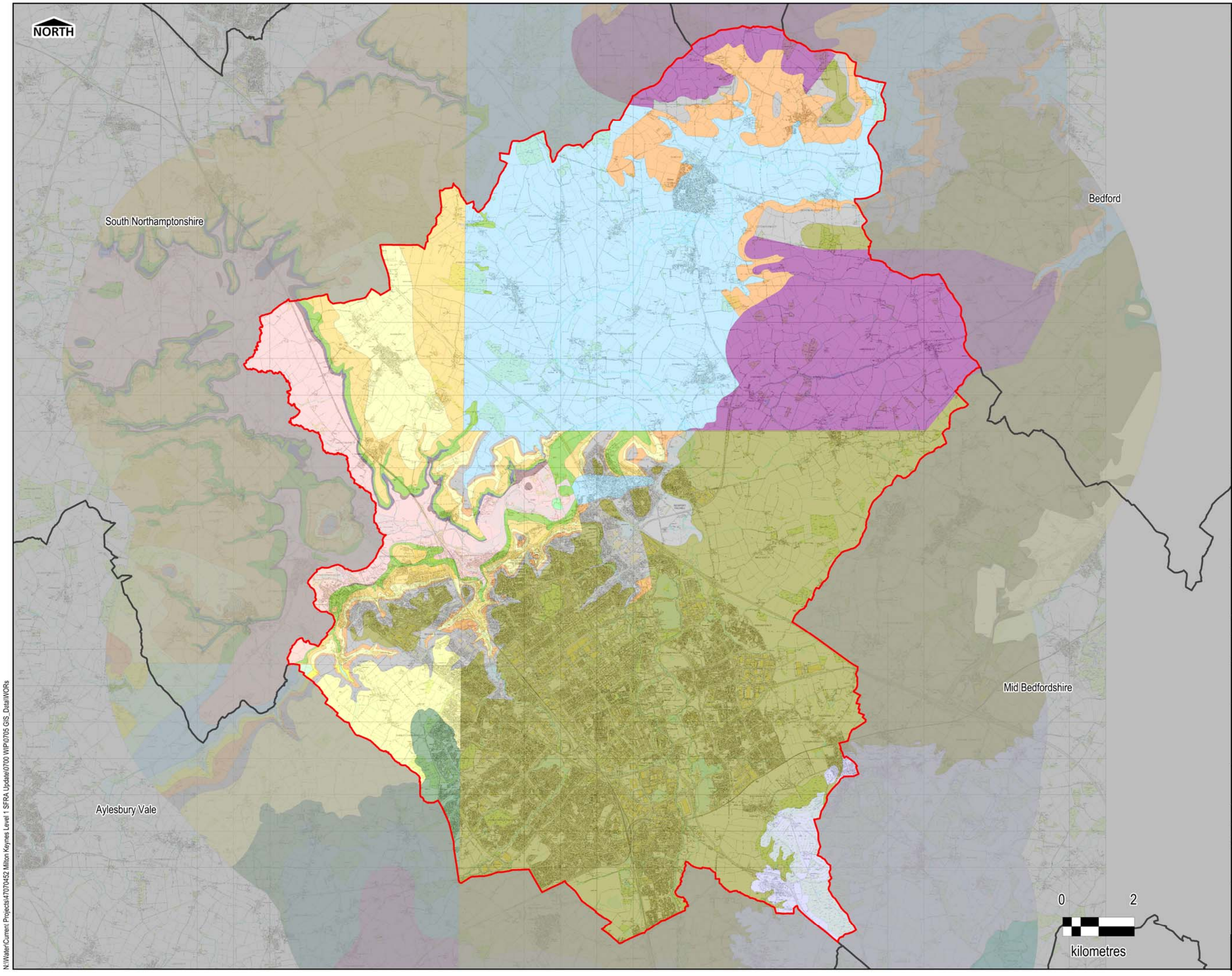

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LEGEND

- Milton Keynes Council Boundary
- Local Planning Authority Boundary

Bedrock Geology

- GAULT FORMATION (G)
- WOBURN SANDS FORMATION (WbS)
- KIMMERIDGE CLAY FORMATION (KC)
- OXFORD CLAY FORMATION (OxC)
- KELLAWAYS FORMATION (Kl)
- CORNBRASH FORMATION (Cb)
- BLISWORTH CLAY FORMATION (BwC)
- BLISWORTH LIMESTONE FORMATION (BwL)
- RUTLAND FORMATION (Rld)
- GREAT OOLITE GROUP (GtO)
- WHITBY MUDSTONE FORMATION (WhM)
- LIAS GROUP (Li)
- KELLAWAYS FORMATION AND OXFORD CLAY FORMATI

Notes

The 1:50,000 scale digital map data is generalised and the geological interpretation should be used only as a guide to the geology at a local level, not as a site-specific geological plan based on detailed site investigations.

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: MILTON KEYNES COUNCIL

Project Title: MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: BEDROCK GEOLOGY

Drawn	Checked	Approved	Date
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FIGURE B4	1

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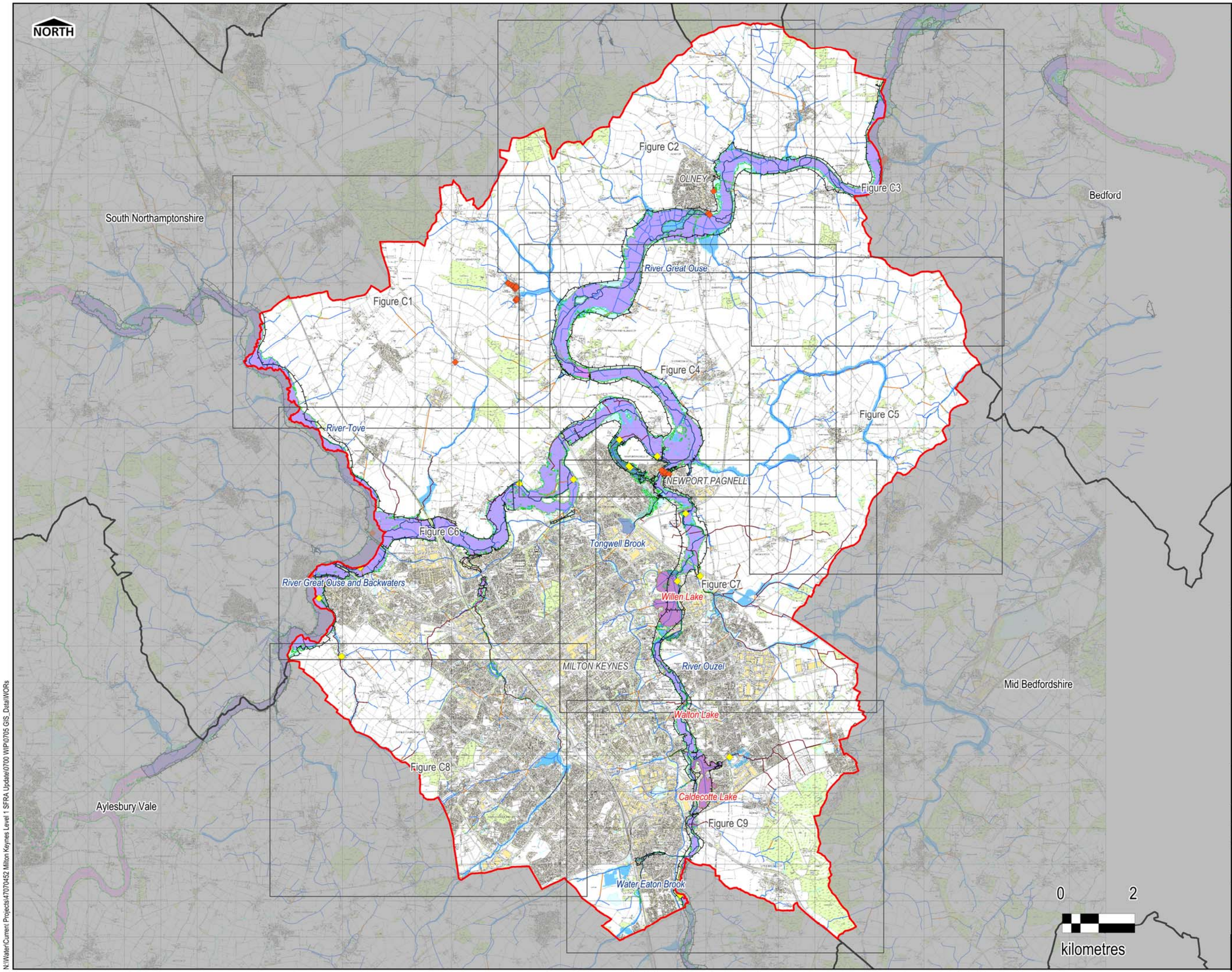

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LEGEND

- Milton Keynes Council Boundary
- Local Planning Authority Boundary
- Main Rivers
- Ordinary Watercourses (Surface Level)
- Ordinary Watercourses (Culverted)
- Drainage Board designated watercourses
- Flood Defences
- Flood Storage Area

Flooding from Rivers

- Flood Zone 1 (<1 in 1000 chance in any year)
- Flood Zone 2 (1 in 1000 chance in any year)
- Flood Zone 3 (1 in 100 chance in any year)
- Flood Zone 3b Functional Floodplain
- 1 in 100 chance including allowance for future climate change
- Areas Benefiting from Defences
- Historic Flood Map
- BGDB Flood Records
- EA Flood Records

Notes

Main Rivers are designated by Defra on a 'Main River Map'. The Environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for Main Rivers only. However overall responsibility for maintenance lies with the riparian owner.

An Ordinary Watercourse is a watercourse that does not form part of a Main River. This includes all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows according to the Land Drainage Act 1991.

Drainage Boards have powers under the Land Drainage Act 1991 (as amended by the 1994 Act) to undertake works on any watercourse within their district other than Main River. A Board's District is defined on a sealed map prepared by the Environment Agency and approved by the relevant Ministry. Within the Drainage Districts, Boards have designated arterial watercourses to which they will normally apply their statutory powers.

The Risk from Rivers is divided into the following categories:
Flood Zone 1 - Land having a less than 1,000 (0.1%) annual probability of river flooding in any year. Shown as clear on the Flood Map - all land outside Flood Zones 2 and 3.
Flood Zone 2 - Land having between a 1 in 100 and 1 in 1,000 (between 1% and 0.1%) annual probability of river flooding in any year.
Flood Zone 3a - Land having a 1 in 100 (1%) or greater annual probability of river flooding in any year.
Flood Zone 3b - Land where water has to flow or be stored in times of flood, or land purposely designed to flood in an extreme event (0.1% AEP). For the purpose of this SFRA, land modelled to have a probability of 5% or greater has been used to delineate Flood Zone 3b.
Where available, modelled outlines showing land having a 1 in 100 (1%) annual probability of flooding including an allowance for climate change have also been mapped.
Further details of the modelling studies used to inform definition of flood zones are provided in the main SFRA Report.

This map is intended to provide a strategic overview of fluvial flood risk and should not be used to assess flood risk for individual properties.

Purpose of Issue: FINAL

Client: MILTON KEYNES COUNCIL

Project Title: MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: RISK OF FLOODING FROM RIVERS

Drawn	Checked	Approved	Date
SL	EG	JR	07/08/2014

URS Internal Project No.: 47070452

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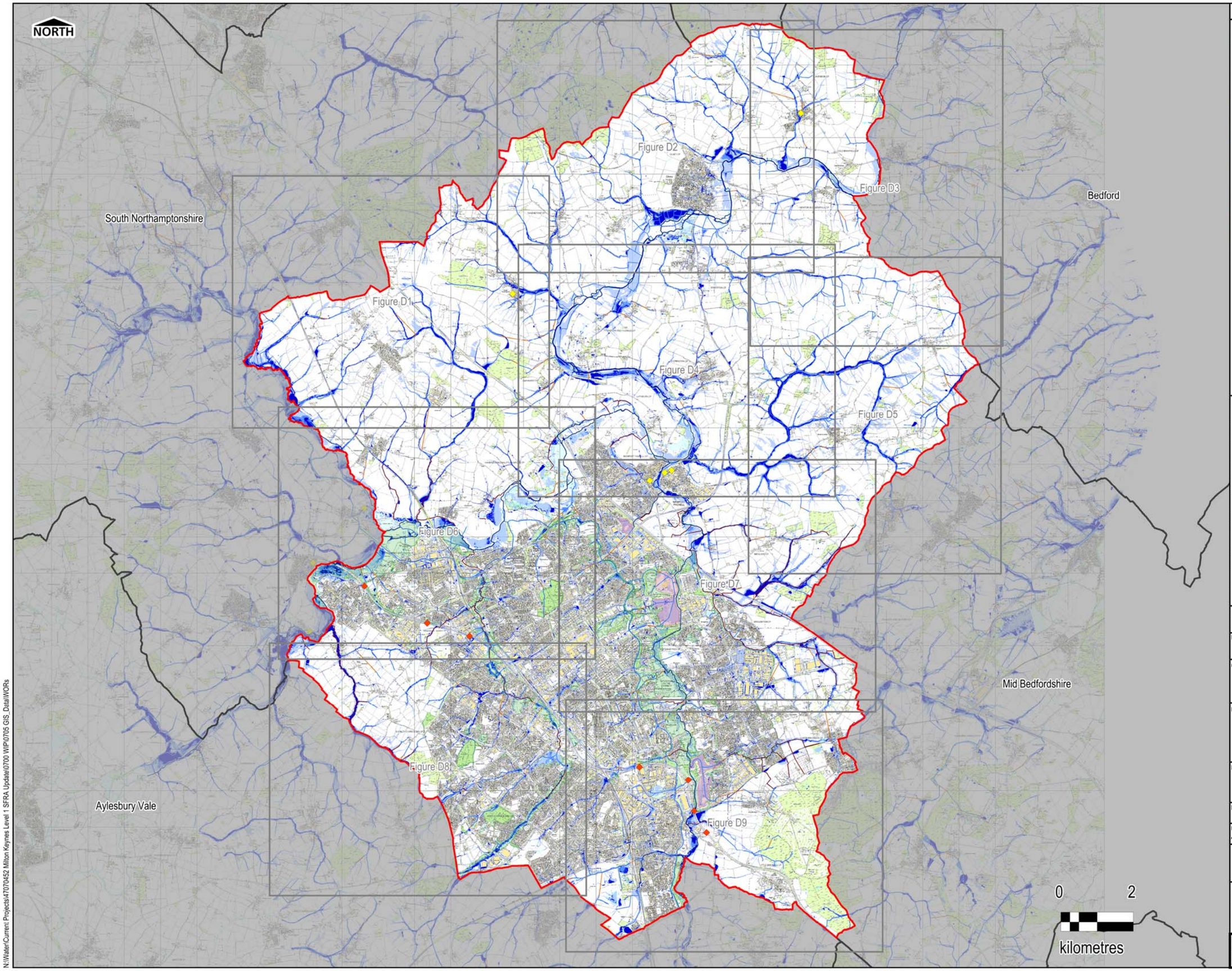

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LEGEND

- Milton Keynes Council Boundary
- Local Planning Authority Boundary
- Main Rivers
- Ordinary Watercourses (Surface Level)
- Ordinary Watercourses (Culverted)
- Drainage Board designated watercourses
- Flood Storage Area
- Linear Park

Risk of Flooding from Surface Water

- High Risk (3.3% AEP)
- Medium Risk (1% AEP)
- Low Risk (0.1% AEP)
- Very Low Risk (<0.1% AEP)
- Historic Flood Records (Highways Agency)
- Historic Flood Records (Environment Agency)

Notes

This map shows the predicted likelihood of surface water flooding based on the Environment Agency's updated Flood Map for Surface Water (uFMfSW) data, which may be subject to further analysis in the future. Further information is provided on the Environment Agency website (www.gov.uk/environment-agency).

The Risk from Surface Water Flooding is divided into categories:
High: each year, the chance of flooding is greater than 1 in 30 (3.3%).
Medium: each year, the chance of flooding is between 1 in 100 (1%) and 1 in 30 (3.3%).
Low: each year, the chance of flooding is between 1 in 1000 (0.1%) and 1 in 100 (1%).
Very Low: each year, the chance of flooding is less than 1 in 1000 (0.1%).

The potential impact of surface water flooding can vary according to the depth of the water, and its velocity (speed and direction that it is flowing in).

Surface water flooding happens when rainwater does not drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead. This type of flooding can be difficult to predict as it is hard to forecast exactly where or how much rain will fall in any storm.

This map is intended to provide a strategic overview of surface water flood risk and should not be used to assess flood risk for individual properties.

Purpose of Issue: FINAL

Client: MILTON KEYNES COUNCIL

Project Title: MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: RISK OF FLOODING FROM SURFACE WATER

Drawn	Checked	Approved	Date
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FIGURE B6	1

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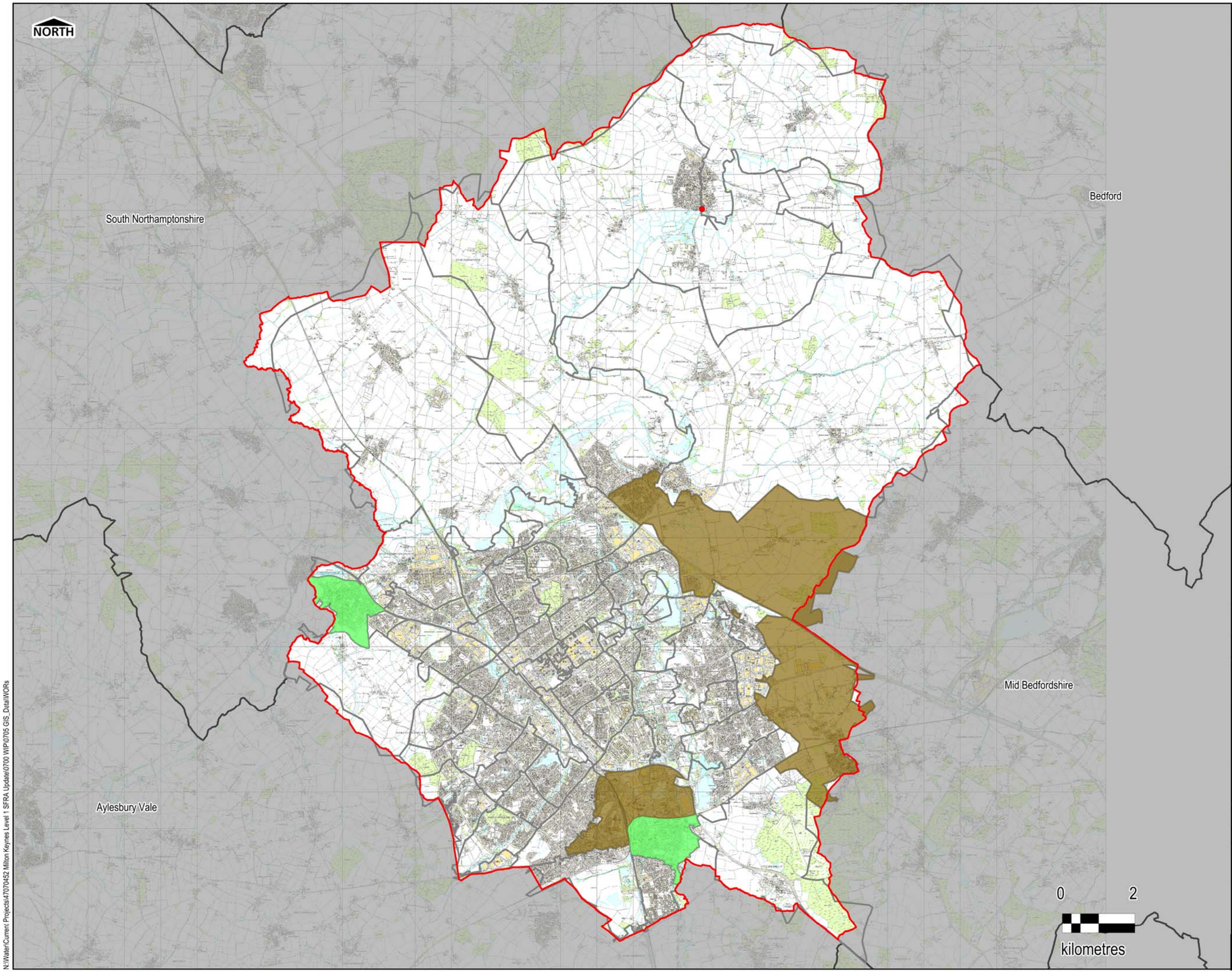

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LEGEND

- Milton Keynes Council Boundary
- Local Planning Authority Boundary
- Post Code Sector Boundary

Anglian Water Sewer Flooding Records (Internal Flooding)

- No Data
- 0 Records
- Internal Flooding (1 Record)
- External Flooding (1 Record)
- Sewer Flood Record (Environment Agency)

Notes

Anglian Water Services has provided an extract from their DG5 Flood Register for the study area. Due to data protection requirements the data has not been provided at individual property level; rather the register comprises the number of properties within 4 digit postcode areas that have experienced flooding either internally or externally within the last 10 years.

It should be noted that records only appear on the DG5 register where they have been reported to AWS, and as such they may not include all instances of sewer flooding.

Furthermore given that AWS target these areas for maintenance and improvements, areas that experienced flooding in the past may no longer be at greatest risk of flooding in the future.

This map is intended to provide a strategic overview of sewer flood risk and should not be used to assess flood risk for individual properties.

Purpose of Issue

FINAL

Client

MILTON KEYNES COUNCIL

Project Title

MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title

RECORDED INCIDENTS OF SEWER FLOODING

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FIGURE B7	1

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NORTH

South Northamptonshire

Bedford

Mid Bedfordshire

Aylesbury Vale

0 2

kilometres

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LEGEND

Milton Keynes Council Boundary

Local Planning Authority Boundary

BGS Susceptibility to Groundwater Flooding

- Potential for groundwater flooding to occur at surface
- Potential for groundwater flooding of property situated below ground level
- Limited potential for groundwater flooding to occur
- Not considered to be prone to groundwater flooding

Groundwater Flood Records (Environment Agency)

Notes

The 1:50,000 scale digital map data is generalised and the geological interpretation should be used only as a guide to the geology at a local level, not as a site-specific geological plan based on detailed site investigations.

This map is intended to provide a strategic overview of susceptibility to groundwater flooding and should not be used to assess flood risk for individual properties.

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: MILTON KEYNES COUNCIL

Project Title: MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: SUSCEPTIBILITY TO GROUNDWATER FLOODING

Drawn	Checked	Approved	Date
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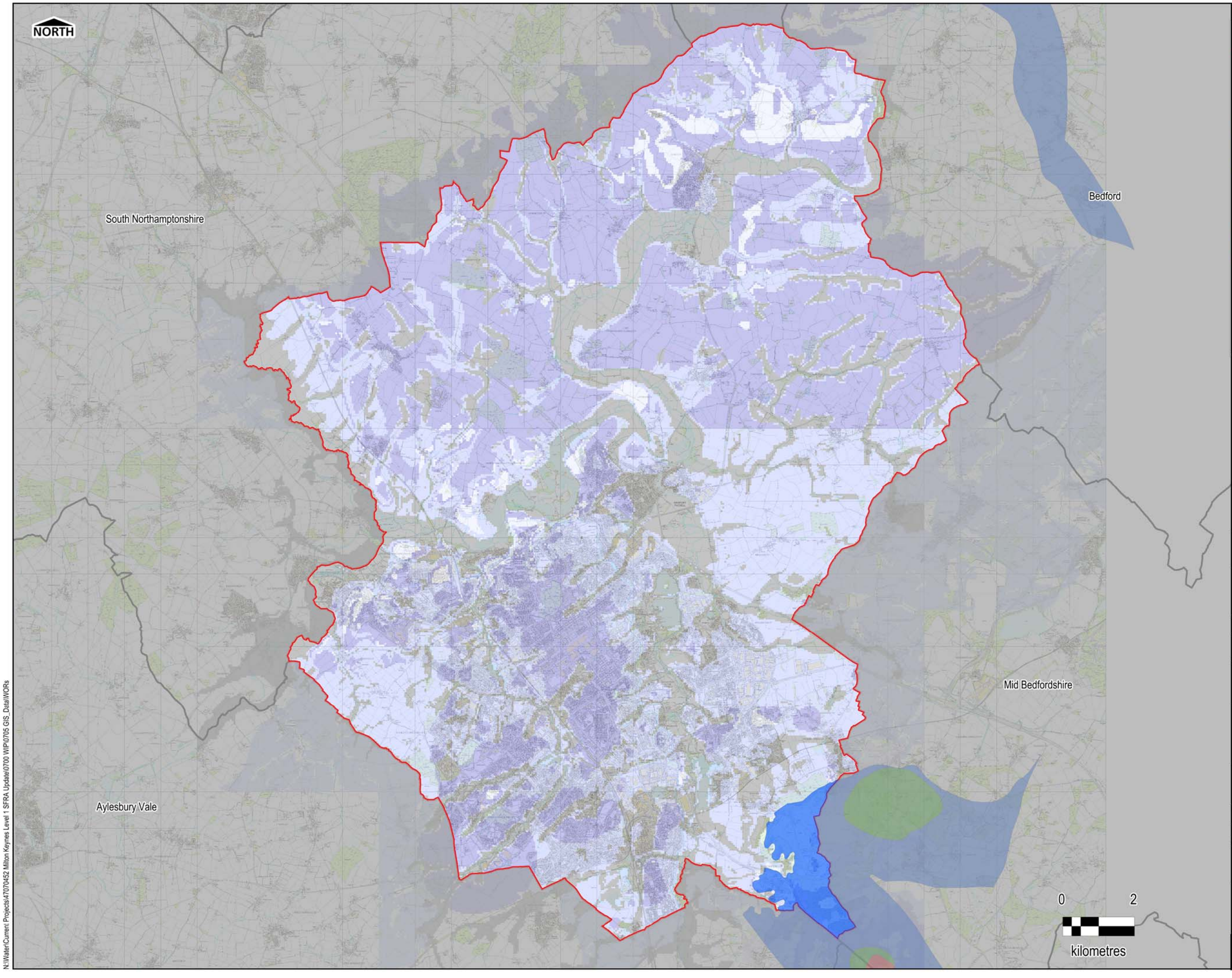

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LEGEND

- Milton Keynes Council Boundary
- Local Planning Authority Boundary

BGS Infiltration SuDS Suitability Map (Detailed)

- Highly compatible for infiltration SuDS
- Probably compatible for infiltration SuDS
- Opportunities for bespoke infiltration SuDS
- Very significant constraints are indicated

BGS Groundwater Source Protection Zones

- Inner Zone
- Outer Zone
- Total Catchment

Notes

The 1:50,000 scale digital map data is generalised and the geological interpretation should be used only as a guide to the geology at a local level, not as a site-specific geological plan based on detailed site investigations.

Descriptions of each of the categories are as follows:
-Highly compatible for infiltration SuDS: The subsurface is likely to be suitable for free-draining infiltration SuDS.
-Probably compatible for infiltration SuDS: The subsurface is probably suitable for infiltration SuDS although the design may be influenced by the ground conditions.
-Opportunities for bespoke infiltration SuDS: The subsurface is potentially suitable for infiltration SuDS although the design will be influenced by the ground conditions.
-Very significant constraints are indicated: There is a very significant potential for one or more geohazards associated with infiltration.

This map is intended to provide a strategic overview of infiltration SuDS suitability and should not be used to assess suitability for individual properties.

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: MILTON KEYNES COUNCIL

Project Title: MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: BGS INFILTRATION SUDS SUITABILITY MAPPING

Drawn	Checked	Approved	Date
CB			

URS Internal Project No.: 47070452
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Drawing Number: FIGURE B9
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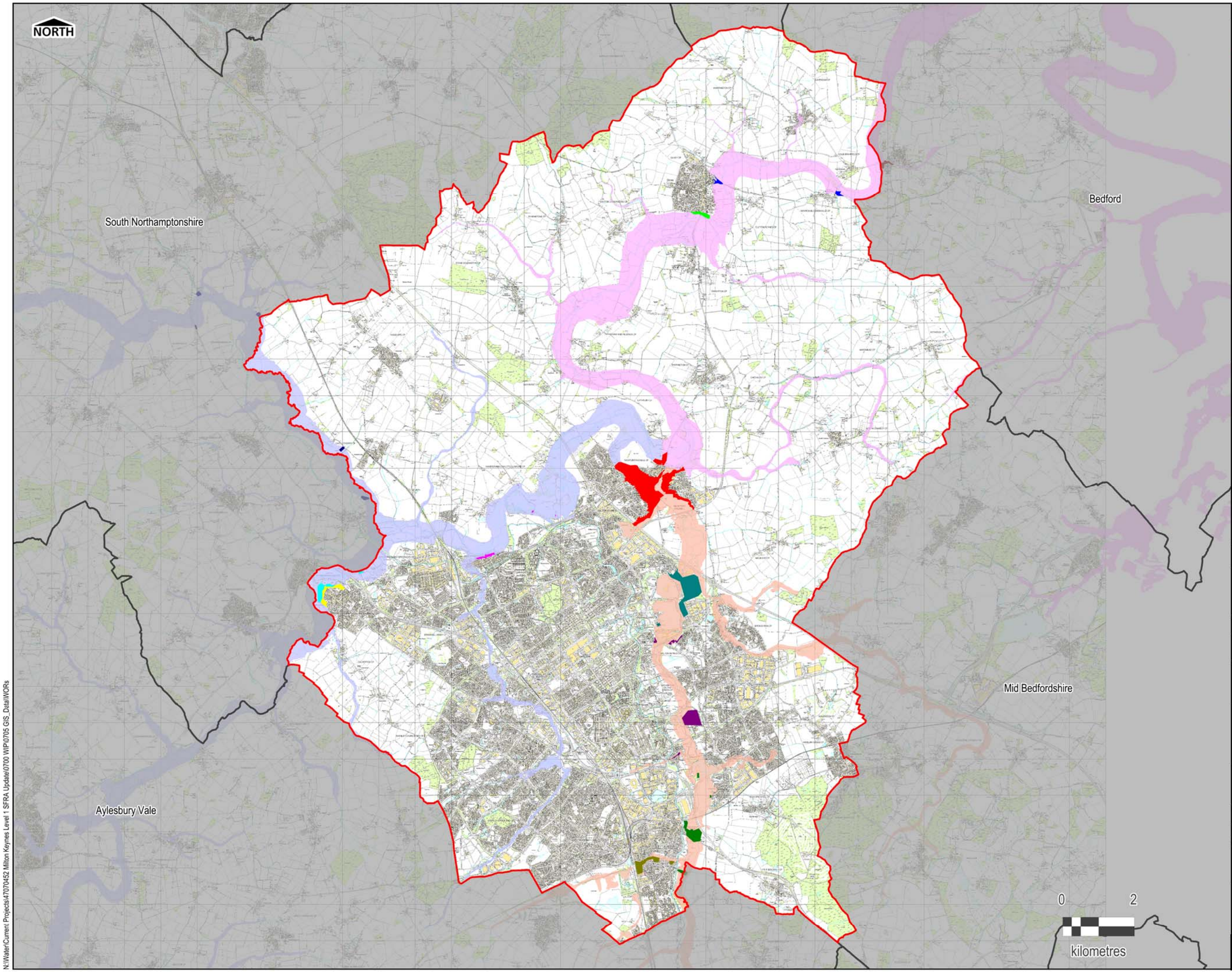

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LEGEND

- Milton Keynes Council Boundary
- Local Planning Authority Boundary

Flood Alert Areas

- River Ouzel and Tributaries
- Upper Ouse and Tributaries
- Great Ouse, Bedfordshire & Buckinghamshire

Flood Warning Areas

- Newport Pagnell
- Olney
- Olney and Newton Blossomville
- River Great Ouse at New Bradwell, Haversham, Great Linford, and Little Linford
- River Great Ouse at Stony Stratford, Old Stratford, Wolverton Mill and Cosgrove
- River Great Ouse at Stony Stratford, Wolverton Mill and Cosgrove
- River Great Ouse at Turvey
- River Ouzel from Bletchley to Walton Park
- River Tove from Towcester Mill to Cosgrove
- Simpson to Willen Lake
- Water Eaton Brook
- Willen Lake

Notes

The Environment Agency provide a free flood warning service for many areas at risk of flooding from rivers and the sea. In some parts of England the Environment Agency may be able to provide warnings when flooding from groundwater is possible. The Environment Agency free flood warning service can provide advance notice of flooding and can provide time to prepare.

The Environment Agency issue flood warnings to homes and businesses when flooding is expected. Upon receipt of a flood warning, occupants should take immediate action.

The Environment Agency issue flood alerts when flooding is possible. Flood alerts cover larger areas than flood warnings and are issued more frequently. Upon receipt of a flood warning, occupants should be prepared for flooding and to take action.

If a flood alert for groundwater is available this does not mean that your property is definitely at risk. It is very difficult to predict the exact location of flooding from groundwater as it is often related to local geology. To help people, the Environment Agency provide flood alerts for large areas that could be affected if groundwater levels were high.

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: FINAL

Client: MILTON KEYNES COUNCIL

Project Title: MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: ENVIRONMENT AGENCY FLOOD WARNING AREAS

Drawn	Checked	Approved	Date
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Drawing Number	Rev
FIGURE B10	1

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APPENDIX C FLUVIAL FLOOD ZONE MAPPING

OVERVIEW MAP

Figure C1
Figure C2
Figure C3
Figure C4
Figure C5
Figure C6
Figure C7
Figure C8
Figure C9

HARTWELL CP
STOKE GOLDINGTON CP
RAVENSTONE CP
HANSLOPE CP
GAYHURST CP
Salcey Forest
Hartwell
Ashton
Salcey Green
Stoke Goldington
Hanslope
Tathall End
River Tove

NORTH

0 0.5 kilometres

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LEGEND

- Milton Keynes Council Boundary
- Local Planning Authority Boundary
- Main Rivers
- Ordinary Watercourses (Surface Level)
- Ordinary Watercourses (Culverted)
- Drainage Board designated watercourses
- Flood Defences
- Flood Storage Area

Flooding from Rivers

- Flood Zone 1 (<1 in 1000 chance in any year)
- Flood Zone 2 (1 in 1000 chance in any year)
- Flood Zone 3 (1 in 100 chance in any year)
- Flood Zone 3b Functional Floodplain
- 1 in 100 chance including allowance for future climate change
- Areas Benefiting from Defences
- Historic Flood Map
- BGDB Flood Records
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Notes

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Where available, modelled outlines showing land having a 1 in 100 (1%) annual probability of flooding including an allowance for climate change have also been mapped.
Further details of the modelling studies used to inform definition of flood zones are provided in the main SFRA Report.

This map is intended to provide a strategic overview of fluvial flood risk and should not be used to assess flood risk for individual properties.

Purpose of Issue: FINAL

Client: MILTON KEYNES COUNCIL

Project Title: MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: RISK OF FLOODING FROM RIVERS

Drawn	Checked	Approved	Date
SL	EG	JR	07/08/2014

URS Internal Project No.: 47070452
Scale at A3: 1:25,000

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Drawing Number: FIGURE C1
Rev: 1

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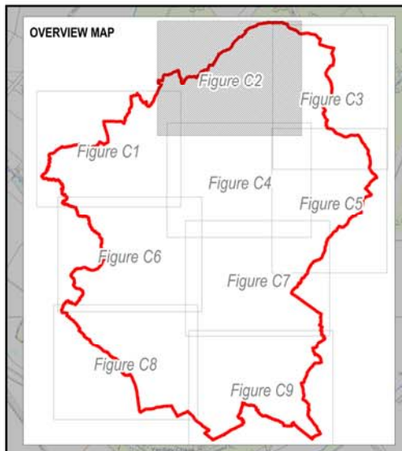

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Purpose of Issue: **FINAL**

Client: MILTON KEYNES COUNCIL

Project Title: **MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT**

Drawing Title: **RISK OF FLOODING FROM RIVERS**

Drawn	Checked	Approved	Date
SL	EG	JR	07/08/2014

URS Internal Project No.: 47070452
Scale at A3: 1:25,000

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Drawing Number: **FIGURE C2**
Rev: 1

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NORTH

LAVENDON CP

COLD BRAYFIELD CP

NEWTON BLOSSOMVILLE CP

CLIFTON REYNES CP

TURVEY CP

ASTWOOD CP

HARDMEAD CP

Lavendon

Cold Brayfield

Newton Blossomville

Hardmead

Astwood

0 0.5 kilometres

OVERVIEW MAP

Figure C1
Figure C2
Figure C3
Figure C4
Figure C5
Figure C6
Figure C7
Figure C8
Figure C9

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Further details of the modelling studies used to inform definition of flood zones are provided in the main SFRA Report.

This map is intended to provide a strategic overview of fluvial food risk and should not be used to assess flood risk for individual properties.

Flooding from Rivers

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Purpose of Issue: FINAL

Project Title: MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Client: MILTON KEYNES COUNCIL

Revision Details	By Chk	Check Date	Suffix

Scale at A3: 1:25,000

Drawn	SL	Checked	EG
Approved	JR	Date	07/08/14

Drawing Title: RISK OF FLOODING FROM RIVERS

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Drawing Number: FIGURE C3

Rev: 1

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NORTH

EMBERTON CP

TYRINGHAM AND FILGRAVE CP

SHERINGTON CP

CHICHELEY CP

GAYHURST CP

LATHBURY CP

NEWPORT PAGNELL CP

ORD CP

Great River Ouse

Emberton

Filgrave

Gayhurst

Sherington

Chicheley

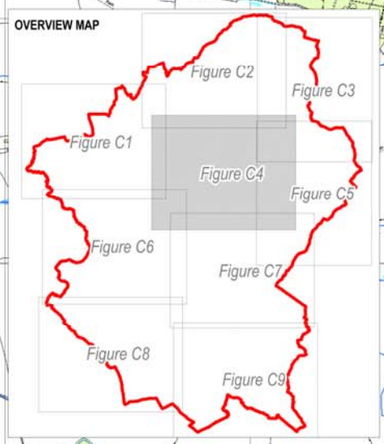
Lathbury

North Crawley

0 0.5

kilometres

OVERVIEW MAP



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LEGEND

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Further details of the modelling studies used to inform definition of flood zones are provided in the main SFRA Report.

This map is intended to provide a strategic overview of fluvial flood risk and should not be used to assess flood risk for individual properties.

Purpose of Issue: **FINAL**

Client: MILTON KEYNES COUNCIL

Project Title: **MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT**

Drawing Title: **RISK OF FLOODING FROM RIVERS**

Drawn	Checked	Approved	Date
SL	EG	JR	07/08/2014

URS Internal Project No.: 47070452

Scale at A3: 1:25,000

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Drawing Number: **FIGURE C4**

Rev: 1

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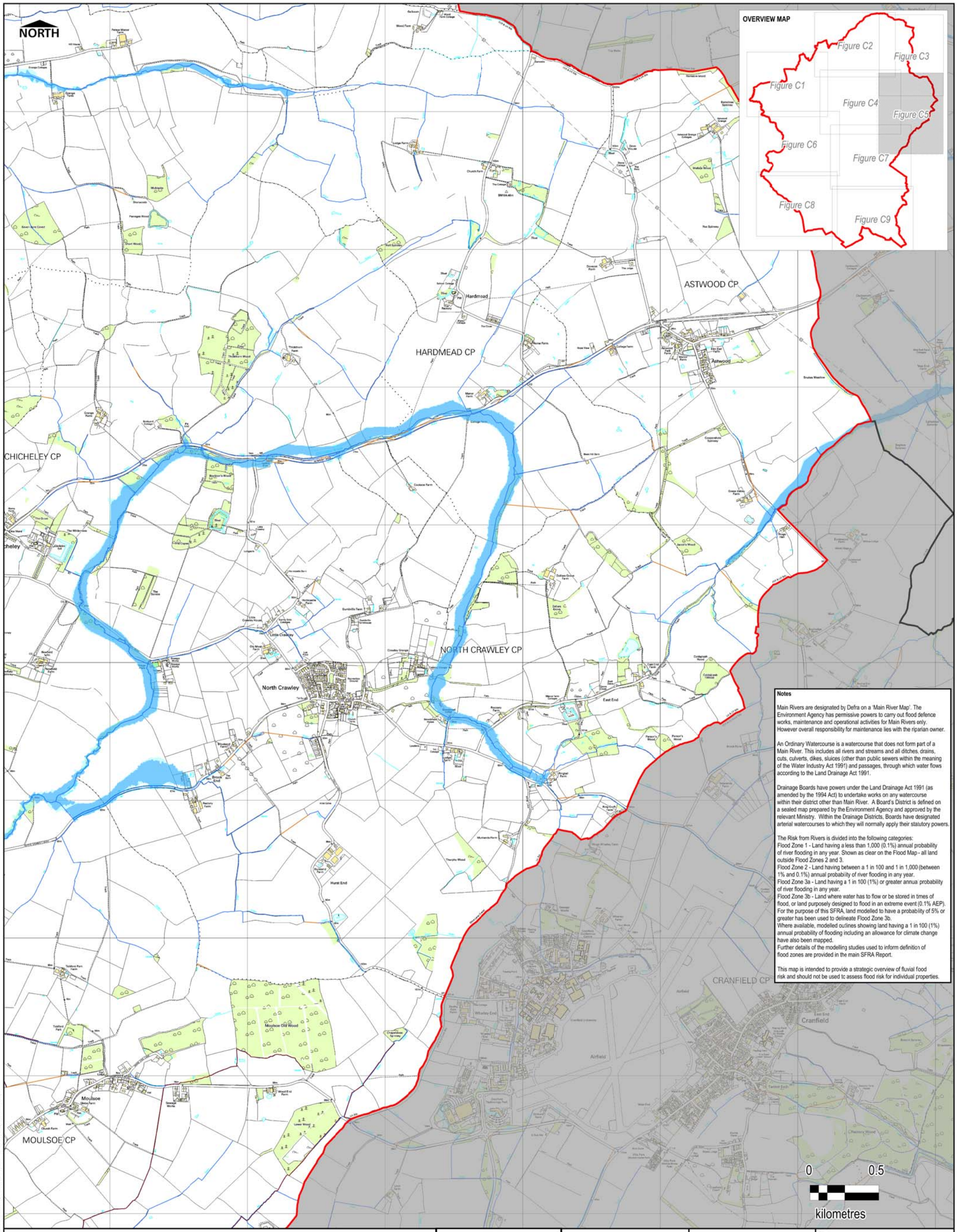

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Revision Details / By / Chk / Check Date / Suffix	Scale at A3: 1:25,000	Drawing Title: RISK OF FLOODING FROM RIVERS	URS Infrastructure & Environment UK Ltd, 6 - 8 Greencoat Place, London, SW1P 1PL, Tel. +44 (0)207 7985000, www.urs.com/uki	
	Drawn SL / Checked EG / Approved JR / Date 07/08/14		Drawing Number: FIGURE C5	Rev: 1
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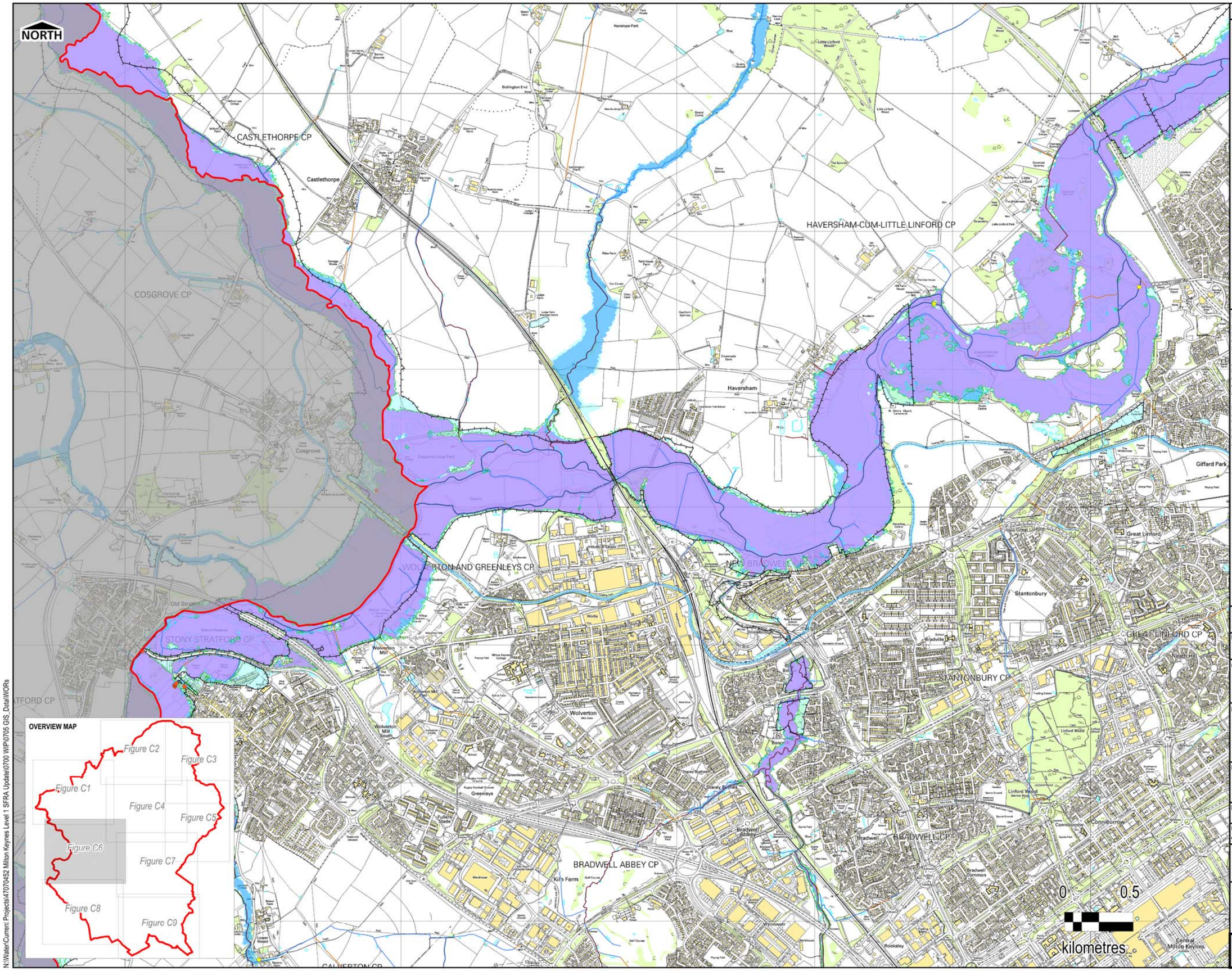

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Purpose of Issue: **FINAL**

Client: MILTON KEYNES COUNCIL

Project Title: **MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT**

Drawing Title: **RISK OF FLOODING FROM RIVERS**

Drawn	Checked	Approved	Date
SL	EG	JR	07/08/2014

URS Internal Project No.: 47070452
Scale at A3: 1:25,000

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Drawing Number: **FIGURE C6**
Rev: 1

OVERVIEW MAP

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NORTH

MILTON KEYNES

NEWPORT PAGNELL

MOULSOE CP

GREAT LINFORD CP

CAMPBELL PARK CP

BROUGHTON CP

MILTON KEYNES CP

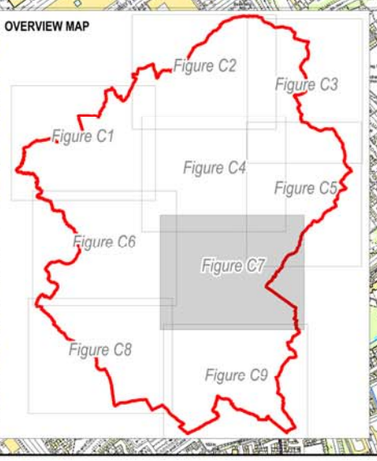
WOUGHTON ON THE GREEN CP

KENTS HILL, MONKSTON AND BRINKLOW CP

Blakelands
Giffard Park
Great Linford
Tongwell
Bolbec Park
Pennylands
Neath Hill
Willen
Willen Park
Pinehurst
Bownhead Park
Downs Barn
Northfield
Atterbury
Conniburrow
Campbell Park
Newlands
Fox Milne
Broughton
Woolstone
Springfield
Milton Keynes Village
Monkston Park
Monkston
Kingston
Industrial Estate
Brinklow
Woughton on the Green
Eaglestone
Portreeve Bridge
Kents Hill
Walnut Tree
Caldecotte
Caldecotte Farm
Moulsoe
Moulsoe Old Wood
Lower Wood
Hurtt End
Lower End
Magna Park

0 0.5 kilometres

OVERVIEW MAP



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Purpose of Issue: **FINAL**

Client: MILTON KEYNES COUNCIL

Project Title: **MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT**

Drawing Title: **RISK OF FLOODING FROM RIVERS**

Drawn	Checked	Approved	Date
SL	EG	JR	07/08/2014

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Drawing Number: **FIGURE C7**
Rev: 1

NORTH

CALVERTON CP

BEACHAMPTON CP

SHENLEY CHURCH END CP

NASH CP

WHADDON CP

SHENLEY BROOK END CP

CENTRAL MILTON KEYNES CP

LOUGHTON CP

WEST BLETCHL

Calverton

Upper Weald

Beachampton

Nash

Whaddon

Wymbush

Two Mile Ash

Rooksley

Loughton Lodge

Loughton

Oldbrook

Crownhill

Grange Farm

Hazeley

Oakhill

Medbourne

Shenley Church End

Shenley Wood

Woodhill

Knowlhill

Winterhill

Eldfield Park

The Bowl

Furzton

Shenley Brook End

Westcroft

Emerson Valley

Tattenhoe

Snelshall West

0 0.5 kilometres

OVERVIEW MAP

Figure C1
Figure C2
Figure C3
Figure C4
Figure C5
Figure C6
Figure C7
Figure C8
Figure C9

THIS DRAWING IS TO BE USED ONLY FOR THE PURPOSE OF ISSUE THAT IT WAS ISSUED FOR AND IS SUBJECT TO AMENDMENT

LEGEND

- Milton Keynes Council Boundary
- Local Planning Authority Boundary
- Main Rivers
- Ordinary Watercourses (Surface Level)
- Ordinary Watercourses (Culverted)
- Drainage Board designated watercourses
- Flood Defences
- Flood Storage Area

Flooding from Rivers

- Flood Zone 1 (<1 in 1000 chance in any year)
- Flood Zone 2 (1 in 1000 chance in any year)
- Flood Zone 3 (1 in 100 chance in any year)
- Flood Zone 3b Functional Floodplain
- 1 in 100 chance including allowance for future climate change
- Areas Benefiting from Defences
- Historic Flood Map
- BGDB Flood Records
- EA Flood Records

Notes

Main Rivers are designated by Defra on a 'Main River Map'. The Environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for Main Rivers only. However overall responsibility for maintenance lies with the riparian owner.

An Ordinary Watercourse is a watercourse that does not form part of a Main River. This includes all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows according to the Land Drainage Act 1991.

Drainage Boards have powers under the Land Drainage Act 1991 (as amended by the 1994 Act) to undertake works on any watercourse within their district other than Main River. A Board's District is defined on a sealed map prepared by the Environment Agency and approved by the relevant Ministry. Within the Drainage Districts, Boards have designated arterial watercourses to which they will normally apply their statutory powers.

The Risk from Rivers is divided into the following categories:
Flood Zone 1 - Land having a less than 1,000 (0.1%) annual probability of river flooding in any year. Shown as clear on the Flood Map - all land outside Flood Zones 2 and 3.
Flood Zone 2 - Land having between a 1 in 100 and 1 in 1,000 (between 1% and 0.1%) annual probability of river flooding in any year.
Flood Zone 3a - Land having a 1 in 100 (1%) or greater annual probability of river flooding in any year.
Flood Zone 3b - Land where water has to flow or be stored in times of flood, or land purposely designed to flood in an extreme event (0.1% AEP). For the purpose of this SFRA, land modelled to have a probability of 5% or greater has been used to delineate Flood Zone 3b.
Where available, modelled outlines showing land having a 1 in 100 (1%) annual probability of flooding including an allowance for climate change have also been mapped.
Further details of the modelling studies used to inform definition of flood zones are provided in the main SFRA Report.

This map is intended to provide a strategic overview of fluvial flood risk and should not be used to assess flood risk for individual properties.

Purpose of Issue: FINAL

Client: MILTON KEYNES COUNCIL

Project Title: MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: RISK OF FLOODING FROM RIVERS

Drawn	Checked	Approved	Date
SL	EG	JR	07/08/2014

URS Internal Project No.: 47070452
Scale at A3: 1:25,000

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Drawing Number: FIGURE C8
Rev: 1

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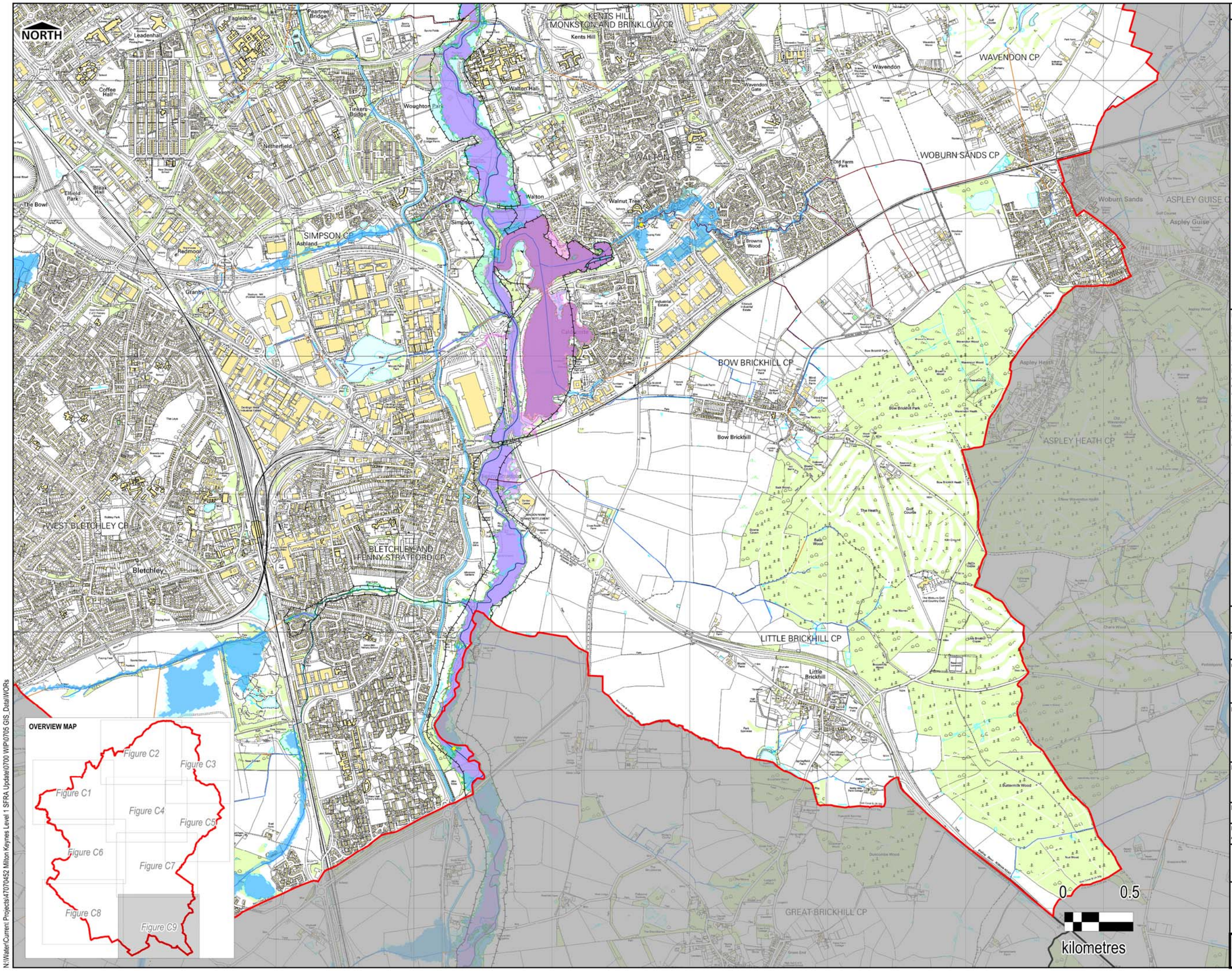

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LEGEND

- Milton Keynes Council Boundary
- Local Planning Authority Boundary
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- Flood Defences
- Flood Storage Area

Flooding from Rivers

- Flood Zone 1 (<1 in 1000 chance in any year)
- Flood Zone 2 (1 in 1000 chance in any year)
- Flood Zone 3 (1 in 100 chance in any year)
- Flood Zone 3b Functional Floodplain
- 1 in 100 chance including allowance for future climate change
- Areas Benefiting from Defences
- Historic Flood Map
- BGDB Flood Records
- EA Flood Records

Notes

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Flood Zone 3b - Land where water has to flow or be stored in times of flood, or land purposely designed to flood in an extreme event (0.1% AEP). For the purpose of this SFRA, land modelled to have a probability of 5% or greater has been used to delineate Flood Zone 3b.
Where available, modelled outlines showing land having a 1 in 100 (1%) annual probability of flooding including an allowance for climate change have also been mapped.
Further details of the modelling studies used to inform definition of flood zones are provided in the main SFRA Report.

This map is intended to provide a strategic overview of fluvial flood risk and should not be used to assess flood risk for individual properties.

Purpose of Issue: **FINAL**

Client: MILTON KEYNES COUNCIL

Project Title: **MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT**

Drawing Title: **RISK OF FLOODING FROM RIVERS**

Drawn	Checked	Approved	Date
SL	EG	JR	07/08/2014

URS Internal Project No.: 47070452
Scale at A3: 1:25,000

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Drawing Number: **FIGURE C9** | Rev: 1

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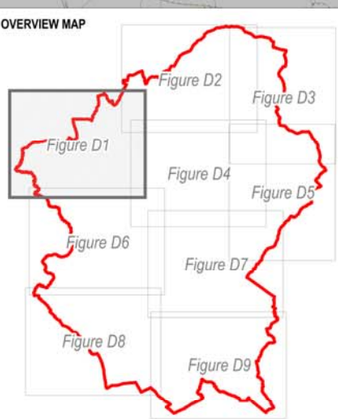
APPENDIX D SURFACE WATER FLOOD RISK MAPPING

NORTH

OVERVIEW MAP



ASHTON CP
HARTWELL CP
GRAFTON REGIS
YARDLEY GOBION CP
HANSLOPE CP
CASTLETHORPE CP
STOKE GOLDINGTON CP
RAVENSTONE CP
GAYHURST CP

0 0.5
kilometres

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LEGEND

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- Ordinary Watercourses (Culverted)
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- Flood Storage Area
- Linear Park

Risk of Flooding from Surface Water

- High Risk (3.3% AEP)
- Medium Risk (1% AEP)
- Low Risk (0.1% AEP)
- Very Low Risk (<0.1% AEP)
- Historic Flood Records (Highways Agency)
- Historic Flood Records (Environment Agency)

Notes

This map shows the predicted likelihood of surface water flooding based on the Environment Agency's updated Flood Map for Surface Water (uFMfSW) data, which may be subject to further analysis in the future. Further information is provided on the Environment Agency website (www.gov.uk/environment-agency).

The Risk from Surface Water Flooding is divided into categories:
High: each year, the chance of flooding is greater than 1 in 30 (3.3%).
Medium: each year, the chance of flooding is between 1 in 100 (1%) and 1 in 30 (3.3%).
Low: each year, the chance of flooding is between 1 in 1000 (0.1%) and 1 in 100 (1%).
Very Low: each year, the chance of flooding is less than 1 in 1000 (0.1%).

The potential impact of surface water flooding can vary according to the depth of the water, and its velocity (speed and direction that it is flowing in).

Surface water flooding happens when rainwater does not drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead. This type of flooding can be difficult to predict as it is hard to forecast exactly where or how much rain will fall in any storm.

This map is intended to provide a strategic overview of surface water flood risk and should not be used to assess flood risk for individual properties.

Purpose of Issue: FINAL

Client: MILTON KEYNES COUNCIL

Project Title: MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: RISK OF FLOODING FROM SURFACE WATER

Drawn	Checked	Approved	Date
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URS Internal Project No.: 47070452
Scale at A3: 1:25,000

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Drawing Number: FIGURE D1
Rev: 1

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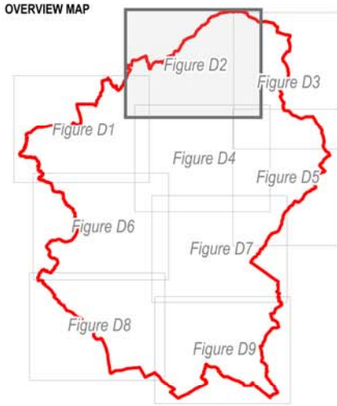
NORTH

OVERVIEW MAP



YARDLEY HASTINGS CP

WARRINGTON CP

OLNEY CP

WESTON UNDERWOOD CP

RAVENSTONE CP

CLIFTON REYNES CP

NEWTON BLOS

Olney

Lavendon

Ravenstone

Emberton

Yardley Chase

Great Wood

0 0.5

kilometres

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LEGEND

- Milton Keynes Council Boundary
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- Main Rivers
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- Ordinary Watercourses (Culverted)
- Drainage Board designated watercourses
- Flood Storage Area
- Linear Park

Risk of Flooding from Surface Water

- High Risk (3.3% AEP)
- Medium Risk (1% AEP)
- Low Risk (0.1% AEP)
- Very Low Risk (<0.1% AEP)
- Historic Flood Records (Highways Agency)
- Historic Flood Records (Environment Agency)

Notes

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Low: each year, the chance of flooding is between 1 in 1000 (0.1%) and 1 in 100 (1%).
Very Low: each year, the chance of flooding is less than 1 in 1000 (0.1%).

The potential impact of surface water flooding can vary according to the depth of the water, and its velocity (speed and direction that it is flowing in).

Surface water flooding happens when rainwater does not drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead. This type of flooding can be difficult to predict as it is hard to forecast exactly where or how much rain will fall in any storm.

This map is intended to provide a strategic overview of surface water flood risk and should not be used to assess flood risk for individual properties.

Purpose of Issue: **FINAL**

Client: MILTON KEYNES COUNCIL

Project Title: **MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT**

Drawing Title: **RISK OF FLOODING FROM SURFACE WATER**

Drawn	Checked	Approved	Date
SL	EG	JR	29/08/2014

URS Internal Project No.	Scale at A3
47070452	1:25,000

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Drawing Number: **FIGURE D2** Rev: **1**

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NORTH

LAVENDON CP

COLD BRAYFIELD CP

NEWTON BLOSSOMVILLE CP

CLIFTON REYNES CP

TURVEY CP

ASTWOOD CP

HARDMEAD CP

Lavendon

Cold Brayfield

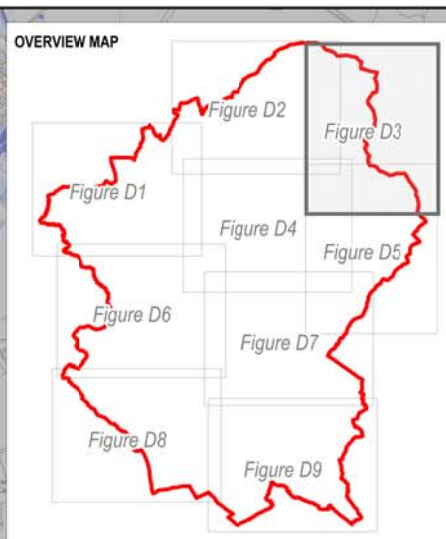
Newton Blossomville

Hardmead

0 0.5

kilometres

OVERVIEW MAP



Notes

This map shows the predicted likelihood of surface water flooding based on the Environment Agency's updated Flood Map for Surface Water (uFMfSW) data, which may be subject to further analysis in the future. Further information is provided on the Environment Agency website (www.gov.uk/environment-agency).

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Low: each year, the chance of flooding is between 1 in 1000 (0.1%) and 1 in 100 (1%).
Very Low: each year, the chance of flooding is less than 1 in 1000 (0.1%).

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This map is intended to provide a strategic overview of surface water flood risk and should not be used to assess flood risk for individual properties.

Risk of Flooding from Surface Water

- High Risk (3.3% AEP)
- Medium Risk (1% AEP)
- Low Risk (0.1% AEP)
- Very Low Risk (<0.1% AEP)
- Historic Flood Records (Highways Agency)
- Historic Flood Records (Environment Agency)
- Milton Keynes Council Boundary
- Local Planning Authority Boundary
- Main Rivers
- Ordinary Watercourses (Surface Level)
- Ordinary Watercourses (Culverted)
- Drainage Board designated watercourses
- Flood Storage Area
- Linear Park

Purpose of Issue: FINAL

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Revision Details | By Chk | Check Date | Suffix

Scale at A3: 1:25,000

Drawn SL | Checked EG

Approved JR | Date 29/08/14

Project Title: MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: RISK OF FLOODING FROM SURFACE WATER

Client: MILTON KEYNES COUNCIL

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Drawing Number: FIGURE D3

Rev: 1

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NORTH

EMBERTON CP

TYRINGHAM AND FILGRAVE CP

SHERINGTON CP

CHICHELEY CP

GAYHURST CP

LATHBURY CP

NEWPORT PAGNELL CP

Emberton
Filgrave
Gayhurst
Sherington
Chicheley
Lathbury
North Crawley

0 0.5
kilometres

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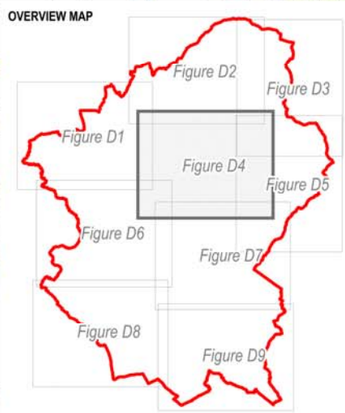
OVERVIEW MAP



LEGEND

- Milton Keynes Council Boundary
- Local Planning Authority Boundary
- Main Rivers
- Ordinary Watercourses (Surface Level)
- Ordinary Watercourses (Culverted)
- Drainage Board designated watercourses
- Flood Storage Area
- Linear Park

Risk of Flooding from Surface Water

- High Risk (3.3% AEP)
- Medium Risk (1% AEP)
- Low Risk (0.1% AEP)
- Very Low Risk (<0.1% AEP)
- Historic Flood Records (Highways Agency)
- Historic Flood Records (Environment Agency)

Notes

This map shows the predicted likelihood of surface water flooding based on the Environment Agency's updated Flood Map for Surface Water (uFMfSW) data, which may be subject to further analysis in the future. Further information is provided on the Environment Agency website (www.gov.uk/environment-agency).

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Surface water flooding happens when rainwater does not drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead. This type of flooding can be difficult to predict as it is hard to forecast exactly where or how much rain will fall in any storm.

This map is intended to provide a strategic overview of surface water flood risk and should not be used to assess flood risk for individual properties.

Purpose of Issue
FINAL

Client
MILTON KEYNES COUNCIL

Project Title
MILTON KEYNES COUNCIL
STRATEGIC FLOOD
RISK ASSESSMENT

Drawing Title
RISK OF FLOODING
FROM SURFACE WATER

Drawn	Checked	Approved	Date
SL	EG	JR	29/08/2014

URS Internal Project No.: 47070452
Scale at A3: 1:25,000

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Drawing Number: FIGURE D4
Rev: 1

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NORTH

HARDMEAD CP

ASTWOOD CP

CHICHELEY CP

NORTH CRAWLEY CP

MOULSOE CP

Hardmead

Astwood

North Crawley

East End

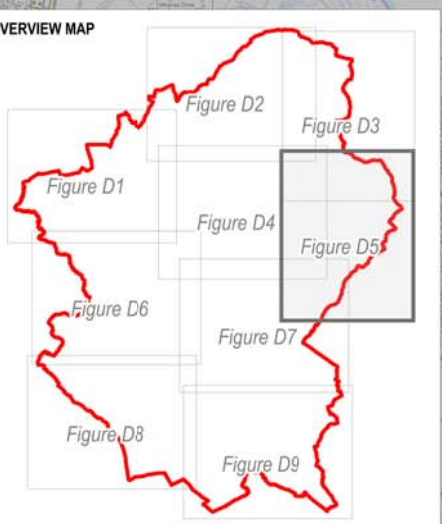
Bourne End

Hurst End

Little Crawley

Moulsoe Old Wood

OVERVIEW MAP



Notes

This map shows the predicted likelihood of surface water flooding based on the Environment Agency's updated Flood Map for Surface Water (uFMfSW) data, which may be subject to further analysis in the future. Further information is provided on the Environment Agency website (www.gov.uk/environment-agency).

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0 0.5

kilometres

Risk of Flooding from Surface Water

- High Risk (3.3% AEP)
- Medium Risk (1% AEP)
- Low Risk (0.1% AEP)
- Very Low Risk (<0.1% AEP)
- Historic Flood Records (Highways Agency)
- Historic Flood Records (Environment Agency)
- Milton Keynes Council Boundary
- Local Planning Authority Boundary
- Main Rivers
- Ordinary Watercourses (Surface Level)
- Ordinary Watercourses (Culverted)
- Drainage Board designated watercourses
- Flood Storage Area
- Linear Park

Purpose of Issue: FINAL

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Project Title: MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Client: MILTON KEYNES COUNCIL

Revision Details	By	Chk	Check Date	Suffix

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Scale at A3: 1:25,000

Drawn	SL	Checked	EG
Approved	JR	Date	29/08/14

Drawing Title: RISK OF FLOODING FROM SURFACE WATER

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Drawing Number: FIGURE D5

Rev: 1

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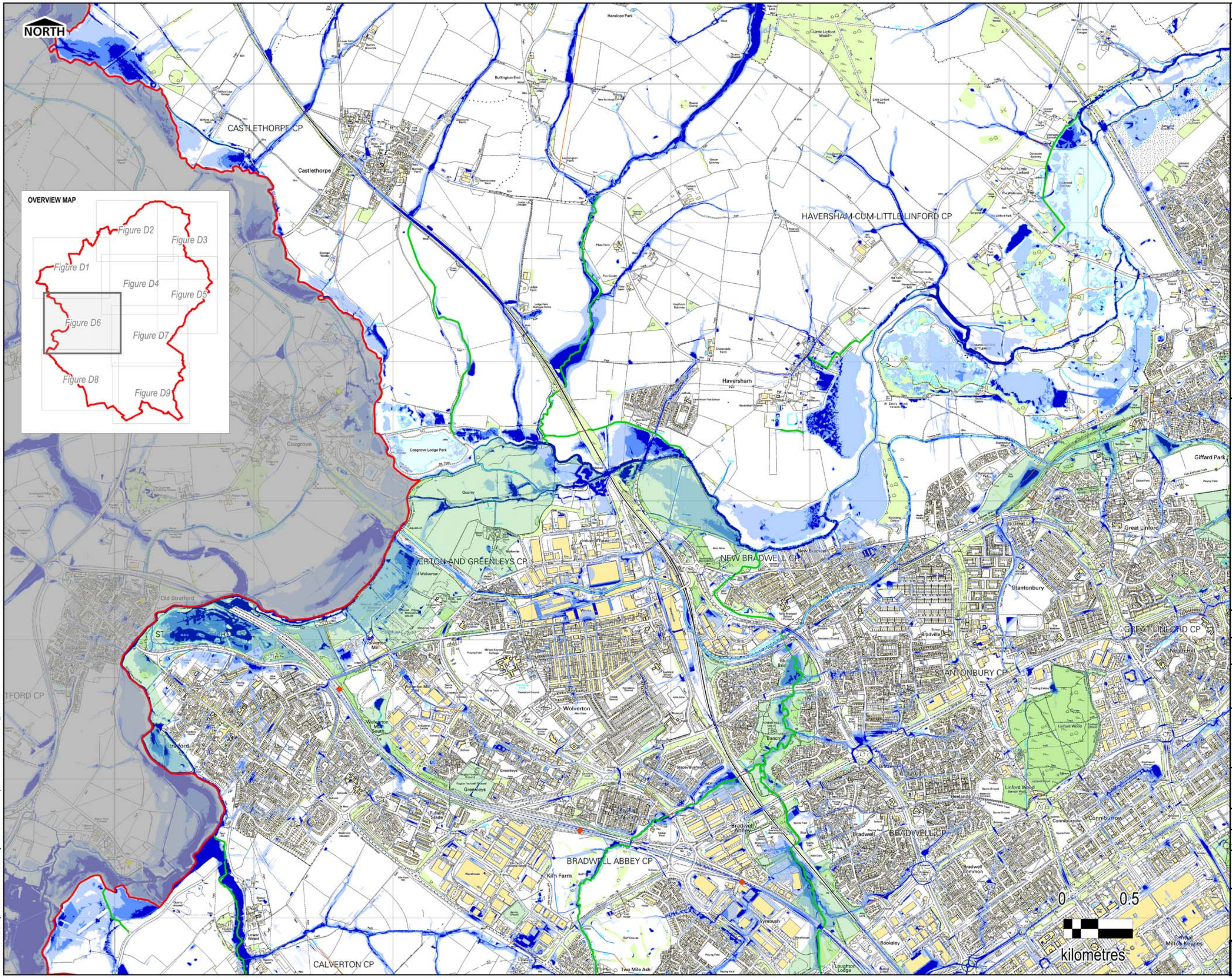

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Risk of Flooding from Surface Water

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This map is intended to provide a strategic overview of surface water flood risk and should not be used to assess flood risk for individual properties.

Purpose of Issue
FINAL

Client
MILTON KEYNES COUNCIL

Project Title
MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title
RISK OF FLOODING FROM SURFACE WATER

Drawn	Checked	Approved	Date
SL	EG	JR	29/08/2014

URS Internal Project No.	Scale at A3
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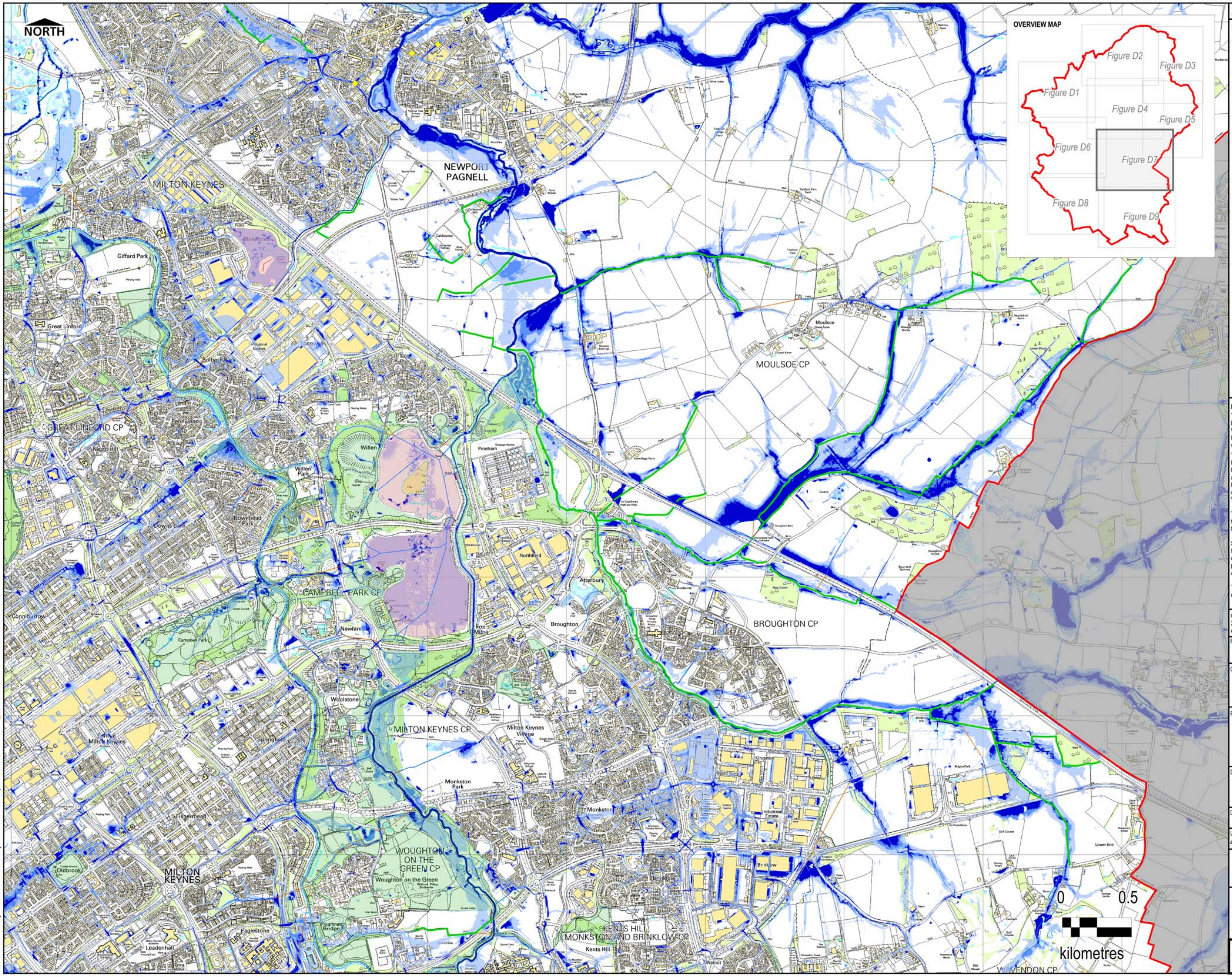

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Risk of Flooding from Surface Water

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- Historic Flood Records (Highways Agency)
- Historic Flood Records (Environment Agency)

Notes

This map shows the predicted likelihood of surface water flooding based on the Environment Agency's updated Flood Map for Surface Water (uFMfSW) data, which may be subject to further analysis in the future. Further information is provided on the Environment Agency website (www.gov.uk/environment-agency).

The Risk from Surface Water Flooding is divided into categories:
High: each year, the chance of flooding is greater than 1 in 30 (3.3%).
Medium: each year, the chance of flooding is between 1 in 100 (1%) and 1 in 30 (3.3%).
Low: each year, the chance of flooding is between 1 in 1000 (0.1%) and 1 in 100 (1%).
Very Low: each year, the chance of flooding is less than 1 in 1000 (0.1%).

The potential impact of surface water flooding can vary according to the depth of the water, and its velocity (speed and direction that it is flowing in).

Surface water flooding happens when rainwater does not drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead. This type of flooding can be difficult to predict as it is hard to forecast exactly where or how much rain will fall in any storm.

This map is intended to provide a strategic overview of surface water flood risk and should not be used to assess flood risk for individual properties.

Purpose of Issue
FINAL

Client
MILTON KEYNES COUNCIL

Project Title
MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title
RISK OF FLOODING FROM SURFACE WATER

Drawn	Checked	Approved	Date
SL	EG	JR	29/08/2014

URS Internal Project No.	Scale at A3
47070452	1:25,000

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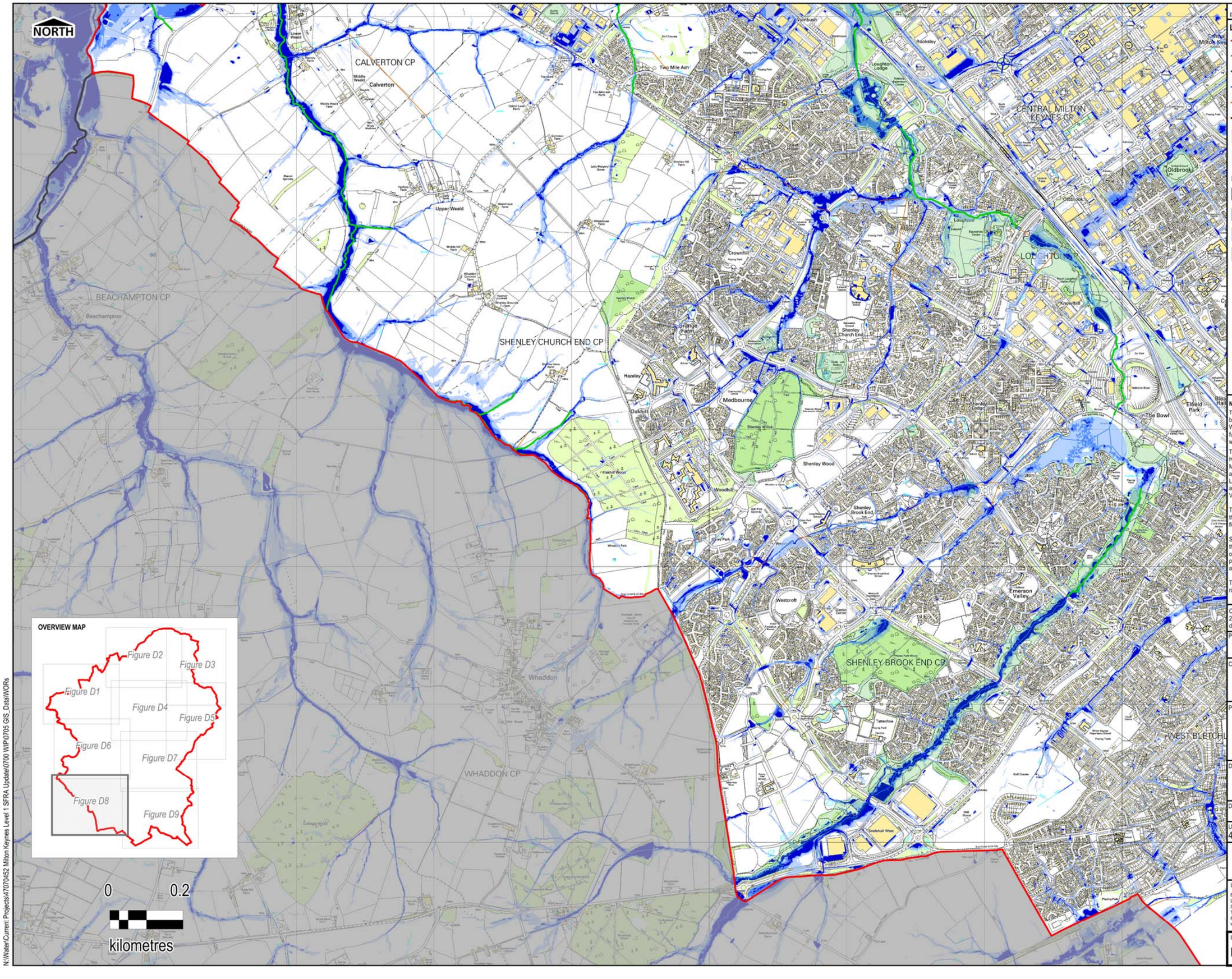
Drawing Number	Rev
FIGURE D7	1



THIS DRAWING IS TO BE USED ONLY FOR THE PURPOSE OF ISSUE THAT IT WAS ISSUED FOR AND IS SUBJECT TO AMENDMENT

LEGEND

- Milton Keynes Council Boundary
- Local Planning Authority Boundary
- Main Rivers
- Ordinary Watercourses (Surface Level)
- Ordinary Watercourses (Culverted)
- Drainage Board designated watercourses
- Flood Storage Area
- Linear Park

Risk of Flooding from Surface Water

- High Risk (3.3% AEP)
- Medium Risk (1% AEP)
- Low Risk (0.1% AEP)
- Very Low Risk (<0.1% AEP)
- Historic Flood Records (Highways Agency)
- Historic Flood Records (Environment Agency)

Notes

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Purpose of Issue: FINAL

Client: MILTON KEYNES COUNCIL

Project Title: MILTON KEYNES COUNCIL STRATEGIC FLOOD RISK ASSESSMENT

Drawing Title: RISK OF FLOODING FROM SURFACE WATER

Drawn	Checked	Approved	Date
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URS Internal Project No.: 47070452

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Drawing Number: FIGURE D8

Rev: 1

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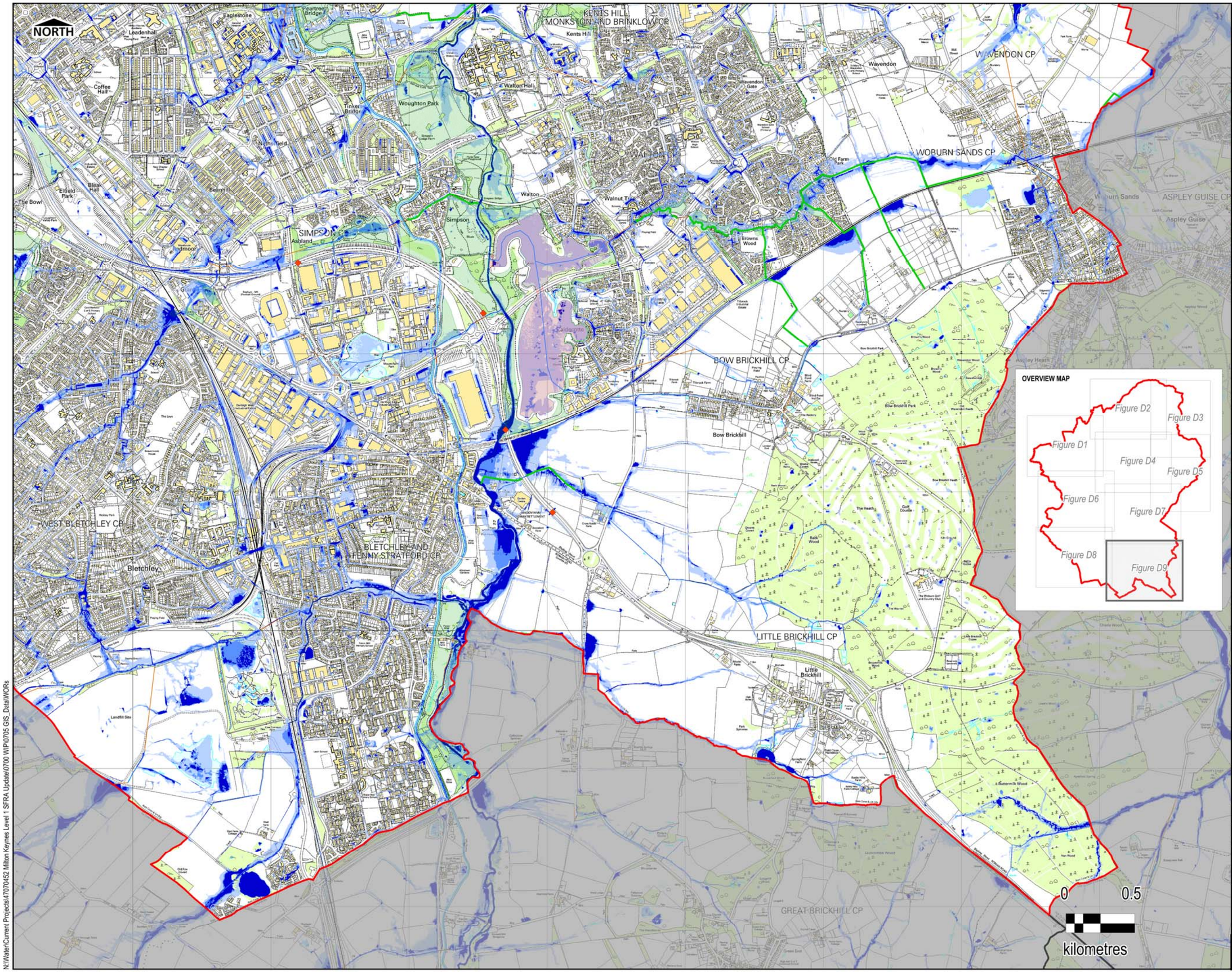

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LEGEND

- Milton Keynes Council Boundary
- Local Planning Authority Boundary
- Main Rivers
- Ordinary Watercourses (Surface Level)
- Ordinary Watercourses (Culverted)
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- Linear Park

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- Low Risk (0.1% AEP)
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- Historic Flood Records (Highways Agency)
- Historic Flood Records (Environment Agency)

OVERVIEW MAP

Notes

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Purpose of Issue: FINAL

Client: MILTON KEYNES COUNCIL

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Drawing Number: FIGURE D9 | Rev: 1

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