Lancaster Level 1 Strategic Flood Risk Assessment Update

Final Report

November 2021

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Contract

This report describes work commissioned by Fiona Clark, on behalf of Lancaster City Council, by an email dated 21 December 2020. Lancaster City Council's representative for the contract was Fiona Clark. Hannah Bishop and Mike Williamson of JBA Consulting carried out this work.

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Purpose

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Acknowledgements

JBA would like to thank representatives of Lancaster City Council, Lancashire County Council, the Environment Agency and United Utilities for information provided to inform this assessment.

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Executive summary

This Level 1 SFRA update is required to inform a partial review of the Local Plan for Lancaster District, specifically relating to policies which relate to the way in which the Council seeks to address climate change. The updated Level 1 SFRA is prepared in support of the Climate Emergency Local Plan Review. This Level 1 SFRA update addresses changes in policy and flood risk since the completion of the October 2017 Level 1 SFRA. Lancashire County Council (LCoC) is the Lead Local Flood Authority (LLFA) for the LCiC administrative area.

This SFRA has been carried out in accordance with Government's latest development planning guidance including the revised National Planning Policy Framework (NPPF) (2021) and flood risk and planning policy guidance, the Flood Risk and Coastal Change Planning Practice Guidance (FRCC-PPG) (last updated March 2014, at the time of writing).

The Review of the Local Plan does not reassess the need for development in the district, including housing numbers, nor does it reconsider sites allocated in the Local Plan. The Level 1 SFRA is focused on collecting readily available flood risk information from a number of stakeholders, the aim being to help identify where flood risks have changed since the adoption of the Local Plan and inform how sites can be developed to mitigate flood risk.

LCiC provided its Local Plan allocations data and information. An updated assessment of flood risk to the allocations has been carried out.

The aims and objectives of this Level 1 SFRA, in line with the NPPF (2021), FRCC-PPG (2014), EA SFRA guidance (2020) and as specified by LCiC's project brief, are to:

- Determine the variations in risk from all sources of flooding across the Local Plan area including:
    - Fluvial and tidal from main rivers, ordinary watercourses, estuaries and coastlines (Flood Map for Planning and functional floodplain),
    - Surface water (pluvial and sewer),
    - Groundwater,
    - Residual risk from reservoirs and canals,
- Determine the risks to and from neighbouring authorities in the same flood catchments,
- Assess existing and future flood risk management, including defence infrastructure, defence types, Standards of Protection, condition as per T98 specifications, Areas Benefitting from Defences and associated residual risk,
- Assess both existing risk and long-term risk using the EA's latest climate change allowances (where available), and also historic flood events,
- Inform the evidence base of the Council's Climate Emergency Local Plan Review so that flood risk is fully taken into account in the preparation of policies for flood risk and water management to ensure no increase in flood risk,
- Rescreen 37 allocated sites against flood risk data to enable application of the Exception Test where necessary, when determining risk at planning application stage.
- Identify the requirements for site-specific flood risk assessments, including for any allocations at risk from sources other than rivers and the sea,
- Determine the acceptability of flood risk in relation to the emergency planning capabilities of the Local Resilience Forum, focusing in particular on identifying safe access and egress routes from new developments, and also EA flood warnings,
- Consider opportunities to reduce flood risk to existing communities and developments through better management of surface water, provision for conveyance, storage of floodwater through appropriate Sustainable Drainage

Systems (SuDS). Also, through natural flood management and the use of green infrastructure and open space for flood storage and amenity use through blue/green corridors,

- Review locations where additional development may significantly increase flood risk elsewhere (cumulative impacts) and where development pressures may require the Exception Test to be applied (i.e. where a Level 2 assessment is required),
- Recommend possible flood mitigation solutions that may be integrated into site design (by the developer) to minimise risk to property and life where flood risk has been identified as a potential constraint to future development,
- Provide a reference and policy document to advise and inform the general public and private and commercial developers of their obligations under the NPPF,
- Enable the SFRA to be used as a tool to inform the Development Management process about the potential risk of flooding associated with future planning applications and the basis for site-specific FRAs where necessary.

A number of allocations are shown to be at varying risk from fluvial, tidal, surface water and residual risk. Table 1 below shows the number of allocations at risk from both fluvial and or tidal flooding.

Proposed use	**Number of sites within…**			
	Flood Zone 1*	**Flood Zone 2**	**Flood Zone 3a**	**Flood Zone 3b**
Residential	9	6	7	9
Employment	0	4	4	6
Mixed Use	1	5	1	4
Commercial	0	1	1	0
Residential / education	1	0	0	0
Employment / education	0	0	0	1
Recreation & environmental improvements	0	1	1	1
TOTAL	**11**	**17**	**14**	**21**

*Sites with 100% area within Flood Zone 1

Note: Sites may be in more than one flood zone. In reality, a site in Flood Zone 3a will also be in Flood Zone 2

Table 1 Number of allocations within each fluvial and/or tidal flood zone

LCiC provided a GIS layer of its 37 sites already allocated within the Local Plan. Nine of these sites already have planning permission however have been included to assess any updated risk.

Appendix B includes a sites assessment spreadsheet detailing the flood risk screening results. Appendix C includes a summary report discussing the results and potential options based on a set of strategic recommendations (see Table 2). The strategic recommendations entail the following:

- Strategic Recommendation A – careful consideration of site layout and design around the identified flood risk which may be complex, i.e. direction of development away from areas at flood risk, and/or incorporation of risk through appropriate mitigation techniques. Development must avoid Flood Zone 3b;

- Strategic Recommendation B – low risk therefore site can progress to site-specific FRA stage which must accompany the planning application;
- Strategic Recommendation C – FRA not required for planning application based on existing risk assessed in this Level 1 SFRA.

Proposed use	Number of sites...		
	A	**B**	**C**
Residential	6	4	1
Employment	6	0	0
Mixed Use	4	3	0
Commercial	1	0	0
Residential / education	0	1	0
Employment / education	1	0	0
Recreation & environmental improvements	1	0	0
TOTAL	**19**	**8**	**1**

Table 2 Number of allocations per strategic recommendation

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Abbreviations

ABD	Area Benefitting from Defences
ACDP	Area with Critical Drainage Problems
AEP	Annual Exceedance Probability
BGS	British Geological Survey
CaBA	Catchment Based Approach
CC	Climate change
CFMP	Catchment Flood Management Plan
CRT	Canal & River Trust
DTM	Digital Terrain Model
EA	Environment Agency
FAA	Flood Alert Area
FAS	Flood Alleviation Scheme
FCDPAG	Flood and Coastal Defence Project Appraisal Guidance
FCERM	Flood and Coastal Erosion Risk Management
FCRMS	Flood and Coastal Risk Management Strategy
FDGiA	Flood Defence Grant in Aid
FEH	Flood Estimation Handbook
FMfP	Flood Map for Planning
FRA	Flood Risk Assessment
FRCC-PPG	Flood Risk and Coastal Change Planning Practice Guidance
FRM	Flood Risk Management
FRMP	Flood Risk Management Plan
FRMS	Flood Risk Management Strategy
FRR	Flood Risk Regulations
FSA	Flood Storage Area
FWA	Flood Warning Area
FWMA	Flood and Water Management Act
GI	Green Infrastructure
GIS	Geographical Information Systems
HFM	Historic Flood Map
LA	Local Authority
LASOO	Local Authority SuDS Officer Organisation
LCiC	Lancaster City Council
LCoC	Lancashire County Council
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
LRF	Lancaster Resilience Forum
MHCLG	Ministry of Housing, Communities and Local Government
NFM	Natural Flood Management
NPPF	National Planning Policy Framework
PFRA	Preliminary Flood Risk Assessment
RBD	River Basin District

RBMP	River Basin Management Plan
RFO	Recorded Flood Outline
RFCC	Regional Flood and Coastal Committee
RMA	Risk Management Authority
RoFRS	Risk of Flooding from Rivers and the Sea
RoFSW	Risk of Flooding from Surface Water
SA	Sustainability Appraisal
SEA	Strategic Environmental Assessment
SFRA	Strategic Flood Risk Assessment
SMP	Shoreline Management Plan
SoP	Standard of Protection
SuDS	Sustainable Drainage System
SWMP	Surface Water Management Plan
UKCP09	UK Climate Projections 2009
UKCP18	UK Climate Projections 2018
UU	United Utilities
WCS	Water Cycle Study
WFD	Water Framework Directive
WwNP	Working with Natural Processes

1 Introduction

1.1 Commission

Lancaster City Council (LCiC) commissioned JBA Consulting in December 2020 for the updating of the 2017 Level 1 Strategic Flood Risk Assessment (SFRA), previously prepared by JBA. LCiC requires this update to bring the SFRA fully in line with the Environment Agency's (EA) 'How to prepare a strategic flood risk assessment[1]' guidance, last updated September 2020, at the time of writing.

This Level 1 SFRA update is required to inform a partial review of the Local Plan for Lancaster District, specifically relating to policies which relate to the way in which the Council seeks to address climate change. The updated Level 1 SFRA is prepared in support of the Climate Emergency Local Plan Review. This Level 1 SFRA update addresses changes in policy and flood risk since the completion of the October 2017 Level 1 SFRA. Lancashire County Council (LCoC) is the Lead Local Flood Authority (LLFA) for the LCiC administrative area.

1.2 Strategic Flood Risk Assessment

All local planning authorities should produce a level 1 SFRA. A level 2 SFRA may also be required depending on whether the Local Authority has plans for development in flood risk areas, identified in the Level 1 SFRA. The EA's SFRA guidance for local planning authorities states:

"Your SFRA will help your planning authority make decisions about:

- *your local plan or spatial development strategy*
- *individual planning applications*
- *how to adapt to climate change*
- *future flood management*
- *emergency planning (the resources needed to make development safe)*

You also need it to help you:

- *carry out the sequential test for the local plan or spatial development strategy, and individual planning applications*
- *do the exception test, when you're proposing to allocate land for development in flood risk areas*
- *establish if a development can be made safe without increasing flood risk elsewhere*
- *decide when a flood risk assessment will be needed for individual planning applications*
- *identify if proposed development is in functional floodplain*
- *do the sustainability appraisal of the local plan or spatial development strategy."*

1.3 Lancaster Level 1 SFRA

This SFRA has been carried out in accordance with Government's latest development planning guidance including the revised National Planning Policy Framework (NPPF) (2021) and flood risk and planning policy guidance, the Flood Risk and Coastal Change Planning Practice Guidance (FRCC-PPG) (last updated March 2014, at the time of writing).

[1] https://www.gov.uk/guidance/local-planning-authorities-strategic-flood-risk-assessment

The latest guidance is available online via:

http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change

An updated version of the NPPF was published on 20 July 2021 and sets out Government's planning policies for England and how these are expected to be applied. This revised Framework replaces the previous versions of the NPPF published in March 2012, July 2018 and December 2019 and is available via:

https://www.gov.uk/government/publications/national-planning-policy-framework--2#history

The purpose of a SFRA is to highlight areas that may flood, taking into account known sources of flooding and the likely impacts of climate change. This enables the local planning authority to prepare policies for flood risk management of potential areas of flood risk and to make development allocations taking this constraint into account.

It is advised that the SFRA should be used to inform the Sustainability Appraisals of Local Development Documents to provide the basis from which to apply the Sequential Test and Exception Test (if applicable) which may be required if it is not possible to locate development in a flood zone with a lower probability of flooding, most preferably Flood Zone 1.

The objective for the Local Plan process is to allocate land for vulnerable uses in lower flood risk flood zones. The SFRA will provide an aid to decision-making and forms part of the evidence base for the Climate Emergency Local Plan Review on the issue of flooding and revised water management policies.

This SFRA assesses the spatial distribution of flood risk across the local authority area, and provides the discussion and guidance required to put this information into practice when taking account of flood risk in development plans and the level of detail required to carry out site specific Flood Risk Assessments (FRAs).

This SFRA makes use of the most up-to-date flood risk datasets, available at the time of submission, to update the extent of risk, at the strategic level, to 37 sites already allocated in the Local Plan by LCiC which acts as the Local Planning Authority (LPA). Lancashire County Council is the Lead Local Flood Authority (LLFA).

The SFRA appendices contain interactive GeoPDF maps (Appendix A) showing the allocated development sites overlaid with the latest, readily available, gathered flood risk information along with the Development Site Assessment spreadsheet (Appendix B) indicating the level of flood risk to each allocation following a strategic assessment of risk. Each allocated site is assigned a strategic recommendation. This information will allow the LPA to identify where the flood risk has changed since the 2017 SFRA and Local Plan allocation and where an Exception Test will be required at the application stage.

The Review of the Local Plan does not reassess the need for development in the district, including housing numbers, nor does it reconsider sites allocated in the Local Plan. A Sequential Test has therefore not been carried out for the allocated sites.

1.4 Aims and objectives

The aims and objectives of this Level 1 SFRA, in line with the NPPF (2021), FRCC-PPG (2014), EA SFRA guidance (2020) and as specified by LCiC's project brief, are to:

- Determine the variations in risk from all sources of flooding across the Local Plan area including:
    - Fluvial and tidal from main rivers, ordinary watercourses, estuaries and coastlines (Flood Map for Planning and functional floodplain),
    - Surface water (pluvial and sewer),

- Groundwater,
- Residual risk from reservoirs and canals,

- Determine the risks to and from neighbouring authorities in the same flood catchments,
- Assess existing and future flood risk management, including defence infrastructure, defence types, Standards of Protection, condition as per T98 specifications, Areas Benefitting from Defences and associated residual risk,
- Assess both existing risk and long-term risk using the EA's latest climate change allowances (where available), and also historic flood events,
- Inform the evidence base of the Council's Climate Emergency Local Plan Review so that flood risk is fully taken into account in the preparation of policies for flood risk management to ensure no increase in flood risk,
- Rescreen 37 allocated sites against flood risk data to enable application of the Exception Test at planning application stage and inform development.
- Identify the requirements for site-specific flood risk assessments, including for any allocations at risk from sources other than rivers and the sea,
- Determine the acceptability of flood risk in relation to the emergency planning capabilities of the Local Resilience Forum, focusing in particular on identifying safe access and egress routes from new developments, and also EA flood warnings,
- Consider opportunities to reduce flood risk to existing communities and developments through better management of surface water, provision for conveyance, storage of floodwater through appropriate Sustainable Drainage Systems (SuDS). Also, through natural flood management and the use of green infrastructure and open space for flood storage and amenity use through blue/green corridors,
- Review locations where additional development may significantly increase flood risk elsewhere (cumulative impacts) and where development pressures may require the Exception Test to be applied (i.e. where a Level 2 assessment is required),
- Recommend possible flood mitigation solutions that may be integrated into site design (by the developer) to minimise risk to property and life where flood risk has been identified as a potential constraint to future development,
- Provide a reference and policy document to advise and inform the general public and private and commercial developers of their obligations under the NPPF,
- Enable the SFRA to be used as a tool to inform the Development Management process about the potential risk of flooding associated with future planning applications and the basis for site-specific FRAs where necessary.

1.5 Consultation

The EA's 2020 SFRA guidance recommends consultation with the following parties, external to the LPA:

- the EA,
- the LLFA,
- emergency planners,
- emergency services,
- water and sewerage companies,
- reservoir owners or undertakers, if relevant,

- internal drainage boards, if relevant,
- highways authorities,
- district councils,
- regional flood and coastal committees.

1.6 SFRA future proofing

This SFRA has been developed using the most up-to-date data and information available at the time of submission. The SFRA has been future proofed as far as possible though the reader should always confirm with the source organisation (LCiC) that the latest information is being used when decisions concerning development and flood risk are being considered. The FRCC-PPG, alongside the NPPF, is referred to throughout this SFRA, being the current primary development and flood risk guidance information available at the time of the finalisation of this SFRA.

The EA's 2020 SFRA guidance states a review of a SFRA should be carried out when there are changes to:

- the predicted impacts of climate change on flood risk,
- detailed flood modelling - such as from the EA or LLFA,
- the local plan, spatial development strategy or relevant local development documents,
- local flood management schemes,
- flood risk management plans,
- local flood risk management strategies,
- national planning policy or guidance.

The SFRA should also be reviewed after a significant flood event. It is in any authority's interest to keep the SFRA as up to date as possible.

Where possible, the SFRA should be kept as a 'live' entity and continually updated when new information becomes available. The EA requests for reports and maps to be published online and be easily updateable, when required.

This SFRA uses the EA's Flood Map for Planning (FMfP) version issued in April 2021 to reassess fluvial and tidal to the Local Plan allocations that may have changed since October 2017. The FMfP is updated at quarterly intervals by the EA, as and when new modelling data becomes available. The reader should therefore refer to the online version of the FMfP to check whether the flood zones may have been updated since April 2021, via the following link:

https://flood-map-for-planning.service.gov.uk/

To assess the surface water risk to the potential development sites, this SFRA uses the EA's Risk of Flooding from Surface Water (RoFSW) dataset, last updated March 2020 at the time of writing. This dataset can be updated periodically when applicable local surface water modelling is carried out that adheres to the EA's required methodology. The reader should therefore refer to the online version of the RoFSW map to check whether the surface water flood outlines have been updated, via the following link:

https://flood-warning-information.service.gov.uk/long-term-flood-risk/map

1.7 Flood risk vulnerability classification

In order to determine the suitability of land for development in flood risk areas, the development vulnerability must first be established. The Flood Risk Vulnerability Classifications are illustrated in Table 1-1.

Classification	Explanation
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 and ambulance stations; fire stations and command centres; 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, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'more vulnerable' class; 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.

Classification	Explanation
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. • Ministry of 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.

Table 1-1 Flood risk vulnerability classification[2]

Flood Risk Vulnerability Classifications		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	✓	×	Exception Test required	×
✓ Development is appropriate × Development should not be permitted						

Table 1-2 Flood risk vulnerability and flood zone 'compatibility'[3]

[2] https://www.gov.uk/guidance/flood-risk-and-coastal-change#Table-2-Flood-Risk-Vulnerability-Classification
[3] https://www.gov.uk/guidance/flood-risk-and-coastal-change#Table-3-Flood-risk-vulnerability

1.8 Flood zone definitions

These Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences. They are shown on the Environment Agency's (EA) Flood Map for Planning (Rivers and Sea), available online.

Flood Zone 1: Low Probability	
Definition	This zone comprises land assessed as having a less than 1 in 1000 annual probability of river and sea flooding in any year (<0.1%).
Appropriate uses	All uses of land are appropriate in this zone.
FRA requirements	For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in an FRA [Flood Risk Assessment]. This need only be brief unless the factors above or other local considerations require particular attention.
Policy aims	In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development and the appropriate application of sustainable drainage techniques.

Table 1-3 Flood Zone 1 definition

Flood Zone 2: Medium Probability	
Definition	This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) and between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.
Appropriate uses	The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure listed in… [The Flood Risk Vulnerability Classification] are appropriate in this zone. Subject to the Sequential Test being applied, the highly vulnerable uses are only appropriate in this zone if the Exception Test is passed.
FRA requirements	All development proposals in this zone should be accompanied by a FRA.
Policy aims	In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques.

Table 1-4 Flood Zone 2 definition

Flood Zone 3a: High Probability	
Definition	This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) and a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
Appropriate uses	The water-compatible and less vulnerable uses of land are appropriate in this zone. The highly vulnerable uses should not be permitted in this zone. The more vulnerable and essential infrastructure should only be permitted in this zone if the Exception Test is passed. Essential Infrastructure permitted in this zone should be designed and constructed to remain operational and safe for user in times of flood.
FRA requirements	All development proposals in this zone should be accompanied by a FRA,
Policy aims	In this zone, developers and local authorities should seek opportunities to: reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques; relocate existing development to land in lower Flood Zones; and Create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocation and safeguarding open space for flood storage.

Table 1-5 Flood Zone 3a definition

Flood Zone 3b: Functional Floodplain	
Definition	This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes).
Appropriate uses	Only the water-compatible uses and the essential infrastructure that has to be there should be permitted in this zone. It should be designate and constructed to: • Remain operational and safe for users in times of flood; • Result in no net loss of floodplain storage; • Not impede water flows; and • Not increase flood risk elsewhere. Essential infrastructure in this zone should pass the Exception test.
FRA requirements	All development proposed in this zone should be accompanied by a FRA.
Policy aims	In this zone, developers and local authorities should seek opportunities to: Reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques; and Relocate existing development to land with a lower probability of flooding.

Table 1-6 Flood Zone 3b definition

2 Study area

According to the 2011 census population estimates[4], 138,375 people live in the Lancaster District. The District covers approximately 57,620 hectares of land and its main settlements are Lancaster, Morecambe, Heysham and Carnforth, as well as many outlying villages and rural hinterland. A section of the Yorkshire Dales National Park lies within the District, as well as parts of the Arnside and Silverdale Area of Outstanding Natural Beauty (AONB) and Forest of Bowland AONB.

Historically, the manufacturing and textiles industry has been important in the District, however employment in this sector fell throughout the 20th century and is now below the national average, with a greater proportion of people now employed in the service sector. Tourism is a significant source of employment, for example in the resort towns of Morecambe and Heysham and historic Lancaster, and the expanding universities in Lancaster are a significant economic asset. The proportion of people employed in agriculture is higher than the national average due to the rural nature of much of the District.

As illustrated by Figure 2-1, the most significant Main Rivers in the District are the River Lune, the River Conder and the River Keer, which all drain south-westwards into the Irish Sea at Morecambe Bay, the River Wyre located in the south-east of the district and the River Wenning, a tributary of the Lune. The Lune is tidally influenced as far as Skerton Weir in Lancaster. Canals in the District include the Lancaster Canal, which runs roughly north-south through the District from Tewitfield to Bay Horse, and the Glasson Branch which extends westwards from Galgate to Glasson Dock. There are numerous ordinary watercourses in the District; ordinary watercourses are any watercourses that are not a designated Main River. These watercourses can vary in size considerably and can include rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices, sewers (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows.

The topography of the area is characterised by higher ground of the Forest of Bowland and Yorkshire Dales to the east, and lower-lying floodplain to the west. The coastal boundary of the District to the west means that there is also a risk of tidal flooding in several communities.

The bedrock of the District is predominantly Millstone Grit (siltstone, sandstone and mudstone), with areas of limestone to the north. This is overlain by superficial deposits of glacial till and alluvium, with areas of peat in upland parts of the Forest of Bowland.

[4] http://www.ons.gov.uk/ons/guide-method/census/2011/index.html

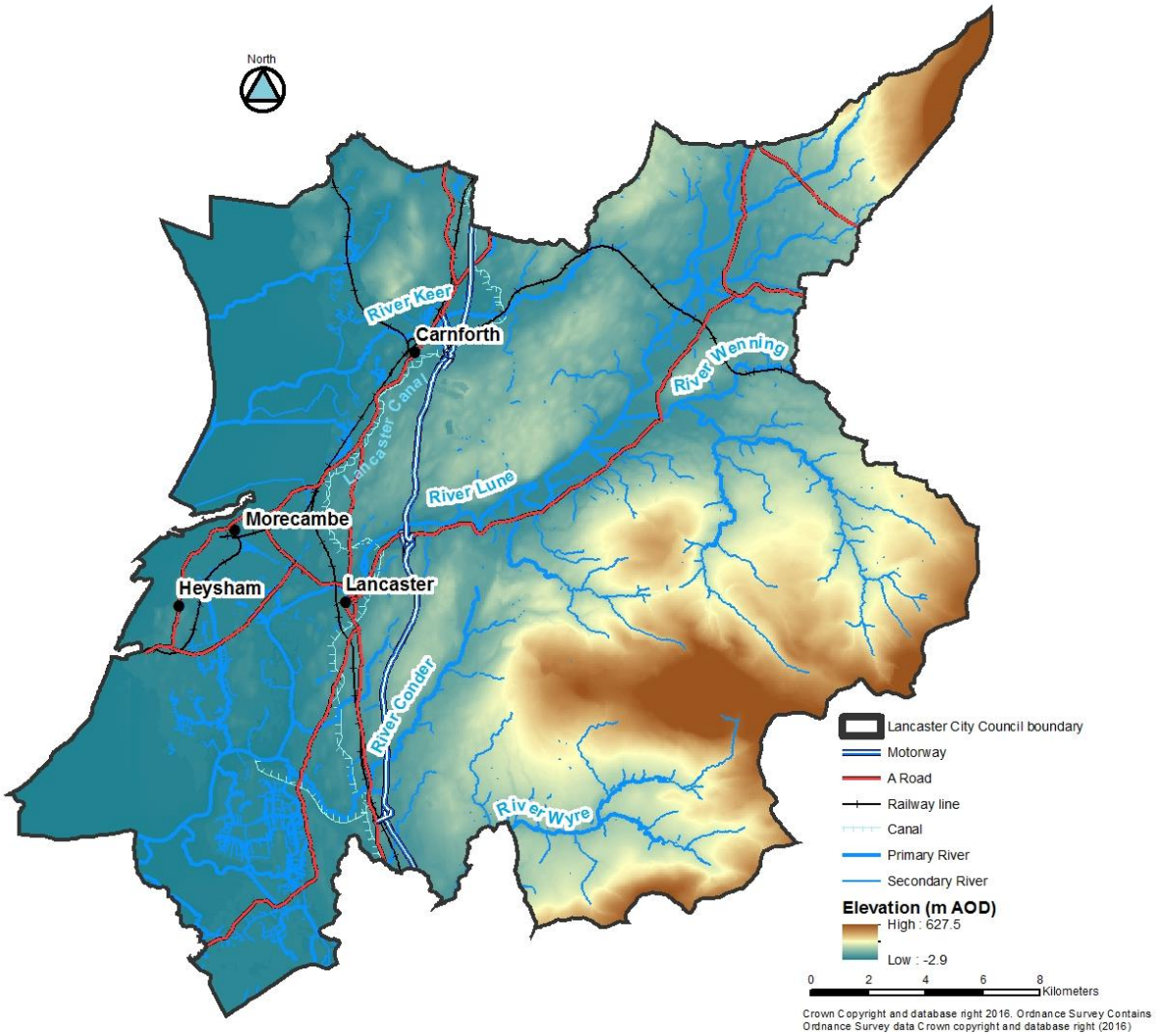

Figure 2-1 SFRA study area

2.1 Main rivers

Main rivers are usually larger rivers and streams. The EA has permissive powers to carry out maintenance, improvement or construction work on main rivers to manage flood risk. The EA also regulate development or works on, over, under or within 8 metres of fluvial main river watercourses (16 metres for tidal main river watercourses) under the Environmental Permitting (England and Wales) Regulations 2016. This also includes within the floodplain, if the works do not have planning permission and works involving quarrying or excavation within 16 metres of any main river, flood defence or culvert. The range of activities subject to regulation are listed at:

https://www.gov.uk/guidance/flood-risk-activities-environmental-permits#check-if-the-activity-is-on-a-main-river

While the EA has permissive powers to undertake works, the maintenance of Main Rivers is primarily the responsibility of riparian owners.

Detailed catchment information is included within Appendix D.

2.2 Ordinary watercourses

Ordinary watercourses are any watercourse not designated as Main River. These watercourses can vary in size considerably and can include rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices, sewers (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows.

LLFAs, district councils and internal drainage boards have statutory permissive powers to carry out flood risk management work on ordinary watercourses. The LLFA has powers under Land Drainage Act to consent works that affect the flow within an ordinary watercourse.

3 Understanding flood risk

3.1 Sources of flooding

Flooding is a natural process and can happen at any time in a wide variety of locations, as discussed below. It constitutes a temporary covering of land not normally covered by water and presents a risk when human or environmental assets are present in the area that floods. Assets at risk from flooding can include housing, transport and public service infrastructure, commercial and industrial enterprises, agricultural land and environmental and cultural heritage. Flooding can occur from many different and combined sources and in many different ways. Major sources of flooding (also see Figure 3-1) include:

- **Fluvial** (main rivers and ordinary watercourses) – inundation of floodplains from rivers and watercourses where the amount of water exceeds channel capacity; inundation of areas outside the floodplain due to influence of bridges, embankments and other features that artificially raise water levels; overtopping or breaching of defences; blockages of culverts; blockages of flood channels/corridors.
- **Tidal** – sea; estuary; overtopping of defences; breaching of defences; other flows (e.g. fluvial surface water) that could pond due to tide locking; wave action.
- **Surface water** – surface water flooding covers two main sources including direct runoff from adjacent land (pluvial) and surcharging of piped drainage systems (public sewers, highways drains, etc.).
- **Groundwater** – water table rising after prolonged rainfall to emerge above ground level remote from a watercourse or into man-made structures below ground level such as basements; most likely to occur in low-lying areas underlain by permeable rock (aquifers); groundwater recovery after pumping for mining or industry has ceased.
- **Infrastructure failure** – reservoirs; canals; industrial processes; burst water mains; blocked sewers or failed pumping stations.

Different types and forms of flooding present a range of different risks and the flood hazards of speed of inundation, depth and duration of flooding can vary greatly. With climate change, the frequency, pattern and severity of flooding are expected to change and become more damaging.

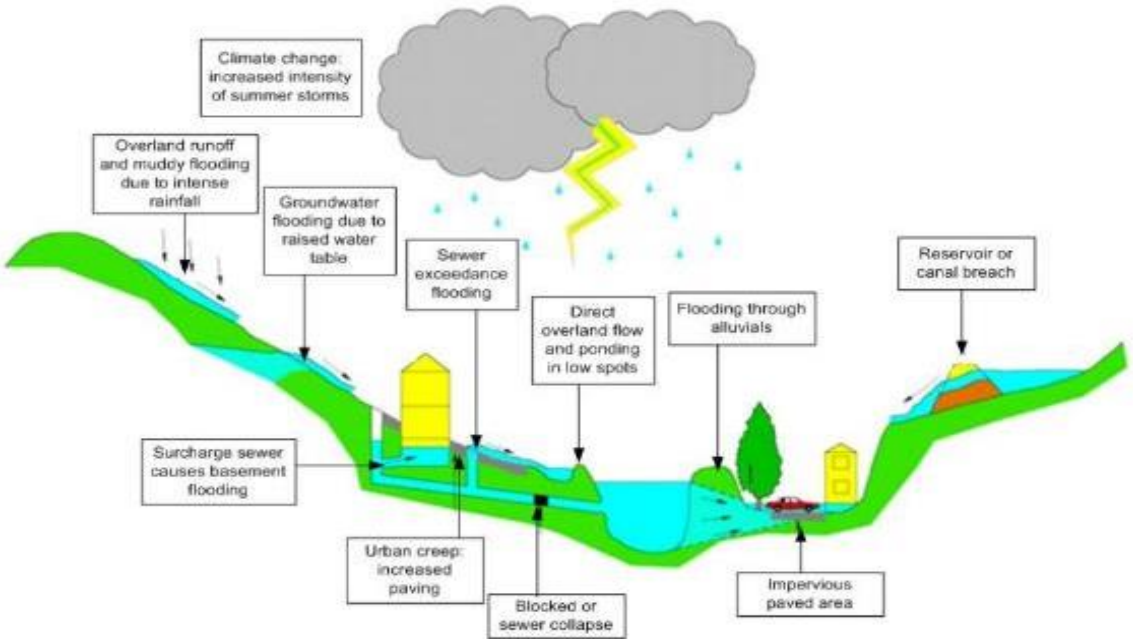

Figure 3-1 Flooding from all sources

3.2 Likelihood and consequence

Flood risk is a combination of the likelihood of flooding and the potential consequences arising. It is assessed using the source – pathway – receptor model as shown in Figure 3-2 below. This is a standard environmental risk model common to many hazards and should be the starting point of any assessment of flood risk. However, it should be remembered that flooding could occur from many different sources and pathways, and not simply those shown in the illustration below.

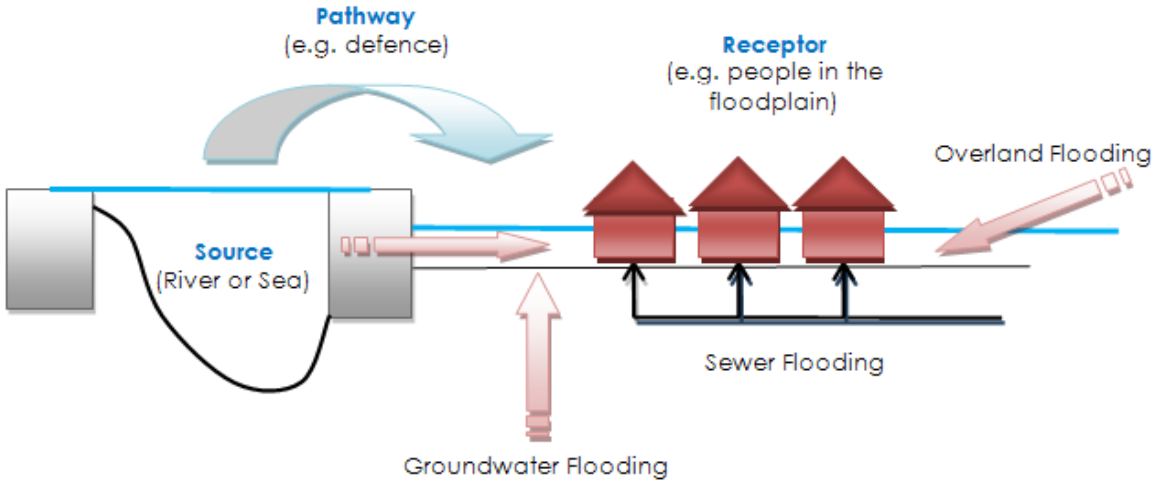

Figure 3-2 Source-Pathway-Receptor Model

The principal sources are rainfall or higher than normal sea levels; the most common pathways are rivers, drains, sewers, overland flow and river and coastal floodplains and their defence assets; and the receptors can include people, their property and the environment. All three elements must be present for flood risk to arise. Mitigation measures have little or no effect on sources of flooding, but they can block or impede pathways or remove receptors.

The planning process is primarily concerned with the location of receptors, taking appropriate account of potential sources and pathways that might put those receptors at risk. It is therefore important to define the components of flood risk in order to apply this guidance in a consistent manner.

3.2.1 Likelihood

Likelihood of flooding is expressed as the percentage probability based on the average frequency measured or extrapolated from records over a large number of years. A 1% probability indicates the flood level that is expected to be reached on average once in a hundred years, i.e. it has a 1% chance of occurring in any one year, such an event may occur more or less than once every hundred years.

- 0.1% AEP = 1 in 1000-year event
- 1% AEP = 1 in 100-year event
- 3.33% AEP = 1 in 30-year event

The FRCC-PPG states that in terms of flood risk and coastal change, the lifetime of residential development should be considered to be a minimum of 100 years, unless there is specific justification for considering a shorter period. **Error! Reference source not found.** provides an example of the flood probabilities used to describe the fluvial and tidal flood zones as defined in the FRCC-PPG and as used by the EA in its Flood Map for Planning (Rivers and Sea).

Note that Flood Zone 3b (the functional floodplain) is not included in the FMfP but is used by the LPA to show where new development should not be permitted. Also note that the FMfP does not take account of the possible impacts of climate change and consequent changes in the future probability of flooding.

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or Land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map)
Zone 3b The Functional Floodplain	**This zone comprises land where water has to flow or be stored in times of flood.** Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

Table 3-1 NPPF flood zones[5]

3.2.2 Consequence

The consequences of flooding include fatalities, property damage, disruption to lives and businesses, with severe implications for people (e.g. financial loss, emotional distress, health problems), disruption of critical infrastructure (e.g. closure of highways, rail networks, impact to electricity supply and other services). Consequences of flooding depend on the hazards caused by flooding (depth of water, speed of flow, rate of onset, duration, wave-action effects, water quality) and the vulnerability of receptors (type of development, nature, e.g. age-structure of the population, presence and reliability of mitigation measures etc.). Flood risk is then expressed in terms of the following relationship:

Flood risk = Probability of flooding x Consequences of flooding

3.3 Risk

Flood risk is not static; it cannot be described simply as a fixed water level that will occur if a river overtops its banks or from a high spring tide that coincides with a storm surge. It is therefore important to consider the continuum of risk carefully. Risk varies depending on the severity of the event, the source of the water, the pathways of flooding (such as the condition of flood defences) and the vulnerability of receptors as mentioned above.

[5] Table 1: Flood Zones, Paragraph 065 of the Flood Risk and Coastal Change Planning Practice Guidance

3.3.1 Actual risk

This is the risk 'as is' taking into account any flood defences that are in place for extreme flood events (typically these provide a minimum Standard of Protection (SoP)). Hence, if a settlement lies behind a fluvial flood defence that provides a 1 in 100-year SoP then the actual risk of flooding from the river in a 1 in 100-year event is generally low. However, the residual risk may be high in that the impact of flood defence failure would likely have a major impact.

Actual risk describes the primary, or prime, risk from a known and understood source managed to a known SoP. However, it is important to recognise that risk comes from many different sources and that the SoP provided will vary within a river catchment. Hence, the actual risk of flooding from the river may be low to a settlement behind the defence but moderate from surface water, which may pond behind the defence in low spots and is unable to discharge into the river during high water levels.

3.3.2 Residual risk

Defended areas, located behind EA, LLFA and private organisation flood defences, remain at residual risk as there is a risk of overtopping or defence breach during significant flood events. Whilst the potential risk of failure may be reduced, consideration of inundation and the impact on development needs to be considered.

Paragraph 041 of the FRCC-PPG defines residual risk as:

"…those remaining after applying the sequential approach to the location of development and taking mitigating actions. Examples of residual flood risk include:

- *The failure of flood management infrastructure such as a breach of a raised flood defence, blockage of a surface water conveyance system, overtopping of an upstream storage area, or failure of a pumped drainage system;*
- *failure of a reservoir, or;*
- *a severe flood event that exceeds a flood management design standard, such as a flood that overtops a raised flood defence, or an intense rainfall event which the drainage system cannot cope with.*

Areas behind flood defences are at particular risk from rapid onset of fast-flowing and deep-water flooding, with little or no warning if defences are overtopped or breached."

Even when flood defences are in place, there is always a likelihood that these could be overtopped in an extreme event where the design standard of protection is exceeded or that they could fail or breach. Where there is a consequence to that occurrence, this risk is known as residual risk. Defence failure can lead to rapid inundation of fast flowing and deep floodwaters, with significant consequences to people, property and the local environment behind the defence. Whilst the actual risk of flooding to a settlement that lies behind a fluvial flood defence that provides a 1 in 100-year SoP may be low, there will always be a residual risk from flooding if these defences overtopped or failed that must be taken into account. Because of this, it is never appropriate to use the term "flood free".

Developers must be able to demonstrate that development will be safe for the lifespan of the development. To that end, Paragraph 042 of the FRCC-PPG states:

"Where residual risk is relatively uniform, such as within a large area protected by embanked flood defences, the Strategic Flood Risk Assessment should indicate the nature and severity of the risk remaining, and provide guidance for residual risk issues to be covered in site-specific flood risk assessments. Where necessary, local planning authorities should use information on identified residual risk to state in Local Plan policies their preferred mitigation strategy in relation to urban form, risk management and where flood mitigation measures are likely to have wider sustainable design implications".

4 The Planning Framework and Flood Risk Policy

4.1 Introduction

Appendix D provides an overview of the key planning and flood risk policy documents that have shaped the current planning framework. It also provides an overview and context of the LLFA's and LPA's responsibilities and duties in respect to managing local flood risk including but not exclusive to the delivery of the requirements of the Flood Risk Regulations (FRR) 2009 and the Flood and Water Management Act (FWMA) 2010[6].

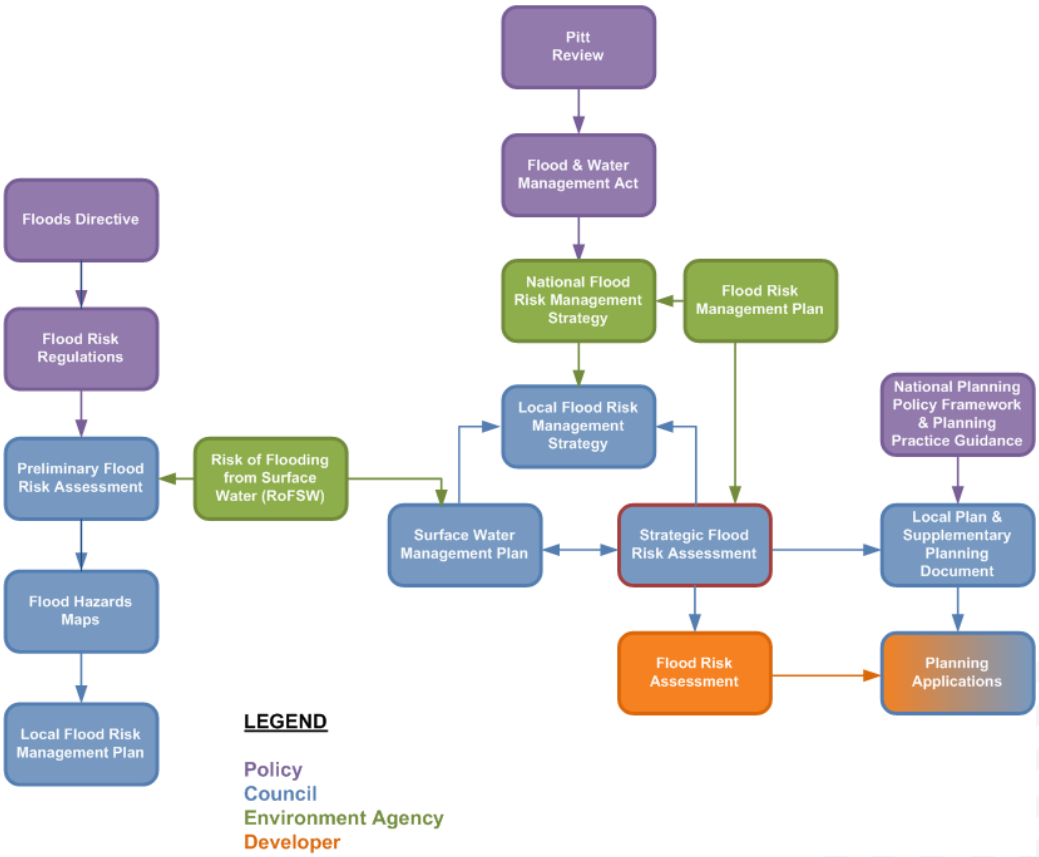

Figure 4-1 illustrates the links between legislation, national policy, statutory documents and assessment of flood risk. The figure shows that whilst the key pieces of legislation and policy are separate, they are closely related, and their implementation should aim to provide a comprehensive and planned approach to asset record keeping and improving flood risk management within communities.

It is intended that the non-statutory Surface Water Management Plans (SWMPs) and SFRAs can provide much of the base data required to support the delivery of the LLFA's statutory flood risk management tasks as well supporting local authorities in developing capacity, effective working arrangements and informing Local Flood Risk Management Strategies (LFRMS) and Local Plans, which in turn help deliver flood risk management infrastructure and sustainable new development at a local level. This SFRA should be used to support the LPA's emerging Local Plan and to help inform planning decisions.

[6] https://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf

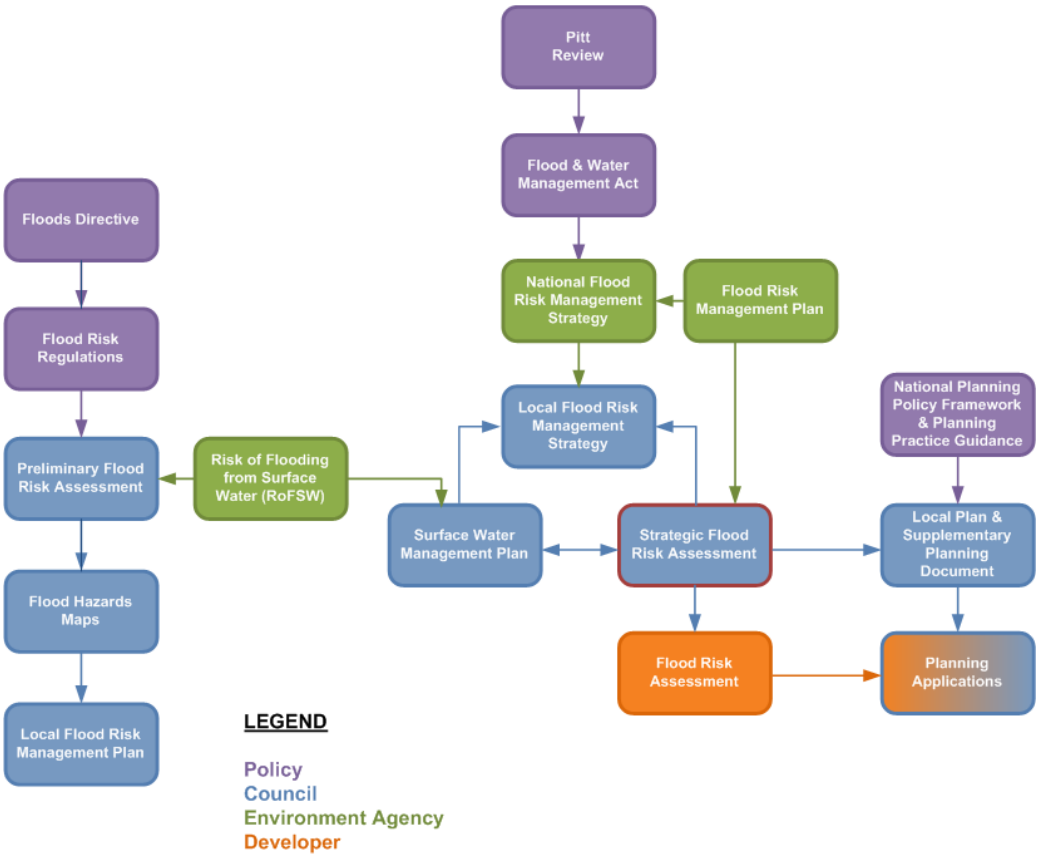

Figure 4-1 Key documents and strategic planning links with flood risk

See Appendix D for details on flood risk and policy.

5 Flood risk across the Lancaster City Council authority area

5.1 Flood risk datasets

This section of the SFRA provides a strategic overview of flood risk from all sources within the LCiC authority area. The information contained is the best available at the time of publication and is intended to provide LCiC with an overview of risk. Table 5-1 provides a summary of the key datasets used in this SFRA according to the source of flooding.

Flood Source	Datasets / Studies
Fluvial	EA Flood Map for Planning (Rivers and Sea) (April 2021)
	EA Risk of Flooding from Rivers and Sea map
	Modelled Flood Outlines (MFO) from latest available EA Flood Risk Mapping Studies
	EA Historic Flood Map (HFM) (April 2021)
	EA Recorded Flood Outlines (RFO) (April 2021)
	EA Areas Benefitting from Flood Defences (ABD) (April 2021)
	EA Flood Warning Areas (April 2021)
Pluvial (surface water runoff)	EA Risk of Flooding from Surface Water (RoFSW) (March 2020)
	Preliminary Flood Risk Assessment (2011 and 2017)
	Draft Surface Water Management Plan (2021)
Sewer	UU Historical Flood Incident Data
Groundwater	BGS Groundwater Potential Flood Map
Reservoir	EA Reservoir Flood Maps (available online)
All sources	North West Flood Risk Management Plan 2016
	North West River Basin Management Plan (June 2018)
	Lune and Wyre Catchment Flood Management Plans (2009)
	Lancashire and Blackpool Local Flood Risk Management Strategy (2013)
	LLFA Historic Flood Records
	Lancaster Level 1 SFRA (2017)
Flood risk management infrastructure	EA Spatial Flood Defence data (August 2020)
	LLFA FRM asset register critical assets

Table 5-1 Flood source and key datasets

5.2 Fluvial and tidal flooding

Fluvial flooding is associated with the exceedance of channel capacity during higher flows or as a result of blockage. The process of flooding from watercourses depends on a number of characteristics associated with the catchment including geographical location and variation in rainfall; steepness of the channel and surrounding floodplain; and infiltration and rate of runoff associated with urban and rural catchments.

Judging from the EA's Flood Map for Planning, the majority of fluvial flood risk comes from the River Lune and its tributaries, as well as the Rivers Keer and Conder. The areas at risk include urban land in Lancaster, as well as rural locations.

Tidal flooding is caused by storm surge and wave action in times of high astronomical tides. The Flood Map for Planning shows there to be extensive tidal flood risk along the coastline, with areas most at risk in Morecambe and the Lune estuary.

The SFRA Maps in Appendix A present the EA's Flood Map for Planning which shows the fluvial coverage of flood zones 2 and 3 across the study area.

5.2.1 EA Flood Map for Planning (Rivers and Sea)

The EA's Flood Map for Planning is the main dataset used by planners for predicting the location and extent of fluvial and tidal flooding. This is supported by the CFMPs and FRMPs along with a number of detailed hydraulic river modelling reports which provide further detail on flooding mechanisms.

The Flood Map for Planning provides flood extents for the 1 in 100 AEP fluvial event (Flood Zone 3), the 1 in 200 AEP tidal event (also Flood Zone 3) and the 1 in 1000 AEP fluvial and tidal flood events (Flood Zone 2). Flood zones were originally prepared by the EA using a methodology based on the national digital terrain model (NextMap), derived river flows from the Flood Estimation Handbook (FEH) and two-dimensional flood routing. Since their initial release, the EA has regularly updated their flood zones with detailed hydraulic model outputs as part of their national flood risk mapping programme. This is in relation to Man Rivers as Ordinary Watercourses do not generally benefit from any refined modelling.

The EA Flood Map for Planning is precautionary in that it does not take account of flood defence infrastructure (which can be breached, overtopped or may not be in existence for the lifetime of the development) and, therefore, represents a worst-case scenario of flooding. The flood zones do not consider sources of flooding other than fluvial and tidal, and do not take account of climate change. For this SFRA, Flood Zone 3 is subdivided into Flood Zone 3a and Flood Zone 3b (functional floodplain - see Section 5.2.2).

The EA also provides a 'Risk of Flooding from Rivers and Sea Map'. This map shows the EA's assessment of the likelihood of flooding from rivers and the sea, at any location, and is based on the presence and effect of all flood defences, predicted flood levels and ground levels. This dataset is not used in the assessment of flood risk for planning applications but is a useful source of information to show the presence and effects of flood risk management infrastructure. This dataset is further discussed in Section 5.2.3.

This SFRA uses the EA's Flood Map for Planning version issued in April 2021 to assess fluvial and tidal risk to potential development sites, as per the NPPF and the accompanying FRCC-PPG. The Flood Map for Planning is updated at quarterly intervals by the EA, as and when new modelling data becomes available. The reader should therefore refer to the online version of the Flood Map for Planning to check whether the flood zones may have been updated since April 2021:

https://flood-map-for-planning.service.gov.uk/

5.2.2 Functional floodplain (Flood Zone 3b)

The functional floodplain forms a very important planning tool in making space for flood waters when flooding occurs. Development should be directed away from these areas.

Table 1, Paragraph 065 of the FRCC-PPG defines Flood Zone 3b as:

"…land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency."

Paragraph 015 of the FRCC-PPG explains 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 with an annual probability of 1 in 20 (5%) or greater in any year, or is designed to flood (such as a flood attenuation scheme) in an extreme (0.1% annual probability) flood, should provide a starting point to help identify the functional floodplain.

The area identified as functional floodplain should take into account the presence and effect of all flood risk management infrastructure including defences. Areas which would naturally flood, but which are prevented from doing so by existing defences and infrastructure or solid buildings, will not normally be identified as functional floodplain. If an area is intended to flood, e.g. an upstream flood storage area designed to protect communities further downstream, then this should be safeguarded from development and identified as functional floodplain, even though it might not flood very often."

A technical note is provided in Appendix E which explains the methodology used in updating the functional floodplain outline for this SFRA. The outline is also displayed on the SFRA Maps in Appendix A.

The EA provided all of its most recent, readily available hydraulic river model 1 in 20 or 1 in 25 year scenario modelled flood outlines for the LCiC area. Where a 1 in 20 year, defended scenario outline was available, this was used to help define the functional floodplain. Where a 1 in 20 year defended scenario outline had not been produced, the 1 in 25 year defended scenario outline was used. Where defended outlines are not available or have not been produced, undefended outlines were used. There are no EA Flood Storage Areas within the LCiC area though the EA Historic Flood Map was assessed for inclusion within the functional floodplain. The functional floodplain outline is reviewed and agreed upon by the EA, based on their local knowledge.

Site-specific FRAs should always further assess the areas of functional floodplain through detailed investigation and assessment of the actual risk and extent of the functional floodplain.

5.2.3 Effects of climate change

EA SFRA guidance states that a Level 1 SFRA should include an assessment on the effects of climate change on flood risk. This Level 1 SFRA has therefore used existing, available EA river and coastal hydraulic models to model these effects.

At the time of completing the climate change modelling for this SFRA, the EA had not released its updated climate change allowances for peak river flows. It was therefore agreed with the EA that, indicative values would be used in the modelling that were greater than the 2016 values and more representative at the catchment scale as opposed to the larger river basin district scale used for the 2016 allowances. The updated peak river flow allowances have since been released.

Section 6.6.1 details the climate change allowances used in the modelling for this SFRA and Appendix C summarises the modelled effects of climate change on long term risk to the 37 allocated sites. Appendix A includes the modelled climate change outlines on the SFRA Maps.

5.2.4 EA Risk of Flooding from Rivers and the Sea map

This Risk of Flooding from Rivers and Sea map (RoFRS) shows the likelihood of flooding from rivers and the sea based on the presence and effect of all flood defences, predicted flood levels and ground levels and is shown on the Appendix A maps. The RoFRS map splits the likelihood of flooding into four risk categories:

- High – greater than or equal to 1 in 30 AEP event (3.3%) chance in any given year
- Medium – less than 1 in 30 AEP event (3.3%) but greater than or equal to 1 in 100 AEP event (1%) chance in any given year
- Low – less than 1 in 100 AEP event (1%) but greater than or equal to 1 in 1000 AEP flood event (0.1%) chance in any given year
- Very Low – less than 1000 AEP event (0.1%) chance in any given year

The RoFRS map is included on the SFRA maps to act as a supplementary piece of information to assist the LPA in the decision-making process for site allocation.

This dataset is not suitable for use with any planning application. The EA's Flood Map for Planning should be used for all planning purposes, as per the FRCC-PPG.

5.3 Surface water flooding

Surface water flood risk should be afforded equal standing in importance and consideration as fluvial flood risk, given the increase in rainfall intensities due to climate change and the increase in impermeable land use due to development.

Surface water flooding, in the context of this SFRA, includes:

- Surface water runoff (also known as pluvial flooding); and
- Sewer flooding

There are certain locations, generally within urban areas, where the probability and consequence of pluvial and sewer flooding are more prominent due to the complex hydraulic interactions that exist in the urban environment. Urban watercourse connectivity, sewer capacity, and the location and condition of highway gullies all have a major role to play in surface water flood risk.

Paragraph 013 of the FRCC-PPG states that SFRAs should address surface water flooding issues by identifying areas of surface water flooding and areas where there may be drainage issues that can cause surface water flooding. The EA's national scale Risk of Flooding from Surface Water (RoFSW) map along with information within the LFRMS should assist with this and various mitigative measures, i.e. SuDS, should be identified. Sections 6.5 and 0 provide guidance on mitigation options and SuDS for developers.

Planning proposals will come forward for Greenfield sites and there will have been no record of previous surface water flooding. Any FRA should bear this in mind and independently evaluate risk from surface water, with reference to the latest information that the LLFA has available and other sources of information.

Judging from the RoFSW, surface water flood risk is prevalent across the District though particularly in the Lune and Keer river valleys and the coast around Morecambe and Lancaster, where the terrain begins to flatten off and surface water can accumulate

It should be acknowledged that once an area is flooded during a large rainfall event, it is often difficult to identify the route, cause and ultimately the source of flooding without undertaking further site-specific and detailed investigations.

5.3.1 Pluvial flooding

Pluvial flooding of land from surface water runoff is usually caused by intense rainfall that may only last a few hours. In these instances, the volume of water from rural land can exceed infiltration rates in a short amount of time, resulting in the flow of water over land. Within urban areas, this intensity can be too great for the urban drainage network resulting in excess water flowing along roads, through properties and

ponding in natural depressions. Areas at risk of pluvial flooding can, therefore, lie outside of the fluvial flood zones.

Pluvial flooding within urban areas across the country will typically be associated with events greater than the 1 in 30 AEP design standard of new sewer systems. Some older sewer and highway drainage networks will have a lower capacity than what is required to mitigate for the 1 in 30 AEP event. There is also residual risk associated with these networks due to possible network failures, blockages or collapses.

Risk of Flooding from Surface Water dataset

The Risk of Flooding from Surface Water (RoFSW), formally referred to as the updated Flood Map for Surface Water (uFMfSW) is the third-generation national surface water flood map, produced by the EA, aimed at helping to identify areas where localised, flash flooding can cause problems even if the Main Rivers are not overflowing. The RoFSW, used in this SFRA to assess risk from surface water, has proved extremely useful in supplementing the EA Flood Map for Planning by identifying areas in Flood Zone 1, which may have critical drainage problems. However, any sites identified to be at risk from surface water flooding should be assessed in more detail, following this SFRA, as the RoFSW is a national-scale dataset and may therefore overestimate or underestimate risk.

The RoFSW includes surface water flood outlines, depths, velocities and hazards for the following events:

- 1 in 30 AEP event (3.3%) – high risk
- 1 in 100 AEP event (1%) – medium risk
- 1 in 1000 AEP event (0.1%) – low risk

The National Modelling and Mapping Method Statement, May 2013 details the methodology applied in producing the map. The RoFSW is displayed on the SFRA maps.

5.3.2 Sewer flooding

Combined sewers spread extensively across urban areas serving residential homes, business and highways, conveying waste and surface water to treatment works. Combined Sewer Overflows (CSOs), provide an EA consented overflow release from the drainage system into local watercourses or large surface water systems during times of high flows. Some areas may also be served by separate waste and surface water sewers which convey wastewater to treatment works and surface water into local watercourses.

Flooding from the sewer network mainly occurs when flow entering the system, such as an urban storm water drainage system, exceeds its available discharge capacity, the system becomes blocked or it cannot discharge due to a high water level in the receiving watercourse. Pinch points and failures within the drainage network may also restrict flows. Water then begins to back up through the sewers and surcharge through manholes, potentially flooding highways and properties. It must be noted that sewer flooding in 'dry weather' resulting from blockage, collapse or pumping station mechanical failure (for example), is the sole concern of the drainage undertaker.

United Utilities (UU) is the water company responsible for the management of the majority of the District's drainage network.

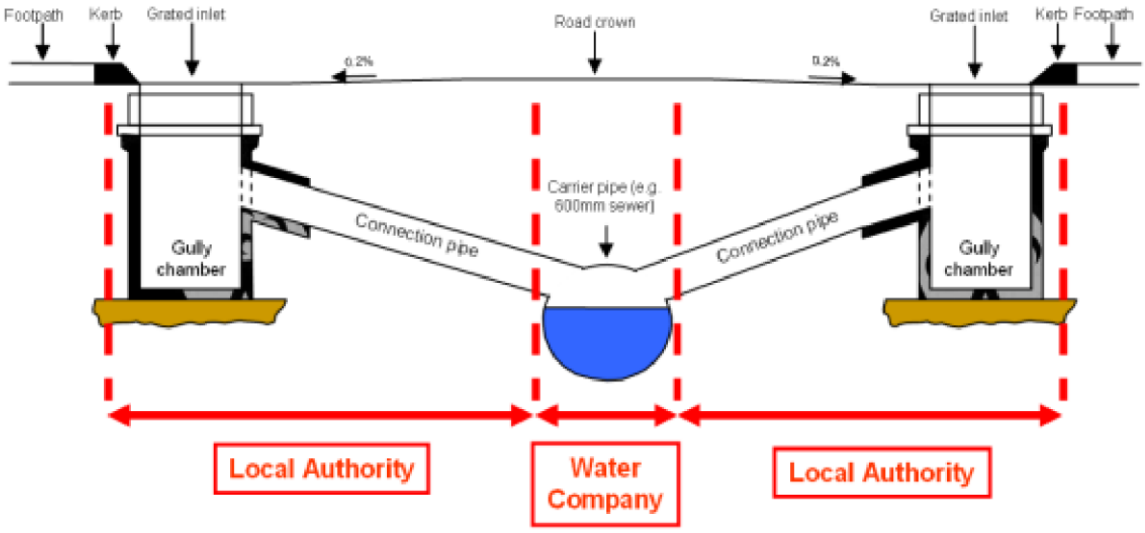

Figure 5-1 Surface water sewer responsibility

As illustrated in Figure 5-1 above, LCoC, as the Highways Authority, is responsible for maintaining an effective highway drainage system including kerbs, road gullies and the pipes which connect the gullies to trunk sewers and soakaways. The sewerage undertaker (UU) is responsible for maintaining the trunk sewers.

Modern drainage networks are designed as separate foul and Surface water sewers. Modern surface water systems are typically designed to accommodate 1 in 30-year AEP storm events. Modern foul sewers are designed for the population, which is to be served, with allowance for infiltration.

Information has been received from UU which identifies locations where sewer flooding incidents have occurred in the District and is located in Section 5.6.3.

5.3.3 Areas with Critical Drainage Problems

The EA can designate Areas with Critical Drainage Problems (ACDPs). ACDPs may be designated where the EA is aware that development within a certain catchment / drainage area could have detrimental impacts on fluvial flood risk downstream, and / or where the EA has identified existing fluvial flood risk issues that could be exacerbated by upstream activities. In these instances, the EA would work with the LLFA and LPA to ensure that adequate surface water management measures are incorporated into new development to help mitigate fluvial flood risk.

EA guidance on carrying out Flood Risk Assessments[7] states that a FRA should be carried out for sites in Flood Zone 1 that are…

"…in an area with critical drainage problems as notified by the Environment Agency."

5.3.4 Locally agreed surface water information

EA guidance, taken from within the FWMA (2010), on using surface water flood risk information recommends that LLFAs, should:

"…review, discuss, agree and record, with the Environment Agency, Water Companies, Internal Drainage Boards and other interested parties, what surface water flood data best represents their local conditions. This will then be known as locally agreed surface water information".

[7] https://www.gov.uk/guidance/flood-risk-assessment-in-flood-zone-1-and-critical-drainage-areas

Based on this, LCiC's 'locally agreed surface water information' should consist of:

- LLFA localised surface water modelling outputs, where and when available,
- The RoFSW map, where the more detailed local LLFA modelling is not available, or
- A combination of both these datasets for defined locations in the LLFA area.

5.4 Groundwater flooding

In simplistic terms, groundwater flooding occurs when the water table rises and water levels in the ground rise above the surface of the land or into man-made below ground structures such as basements. Flooding tends to occur after long periods of sustained heavy rainfall and can last for weeks or even months. The areas most at risk are often low-lying areas where the water table is more likely to be at a shallow depth and flooding can be experienced through water rising up from the underlying aquifer, or from water flowing from springs. Flooding from groundwater is most common in areas where the underlying bedrock is chalk, but it can also happen in locations with sand and gravel.

The EA's 2020 SFRA guidance recommends the use of the British Geological Survey's (BGS) national dataset on the susceptibility of groundwater flooding. Based on geological and hydrogeological information, the digital data can be used to identify areas where geological conditions could enable groundwater flooding to occur and where groundwater may come close to the ground surface.

The dataset is split into three categories, based on the potential of groundwater flooding occurring:

A. Limited potential for groundwater flooding to occur,
B. Potential for groundwater flooding of property situated below ground level,
C. Potential for groundwater flooding to occur at the surface.

There is currently limited research which specifically considers the impact of climate change on groundwater flooding. The mechanisms of groundwater flooding are unlikely to be affected by climate change, however if winter rainfall becomes more frequent and heavier, groundwater levels may increase. Higher winter recharge may however be balanced by lower recharge during the predicted hotter and drier summers.

Further investigation should be carried out as part of the preparation of a site-specific FRA, for any site deemed to be at risk of groundwater flooding i.e. in BGS categories B or C. The FRA should incorporate a site-based assessment of the potential risk of groundwater flooding to the site, confirming from borehole data whether groundwater is a source of flood risk for the site, and setting out any mitigation measures proposed. Onsite infiltration testing should also be carried out; however, it is unlikely that any areas within these categories would be suitable for infiltration-based SuDS.

Categories B and C are distributed across large areas of the district with the main areas including most of the southern areas of the district for areas such as Galgate, Bailrigg, Lancaster City Centre and Conder Green. Other areas such as Morecambe, Carnforth and Tunstall are also within these categories.

The BGS dataset is shown on the SFRA Maps in Appendix A.

5.5 Canal and reservoir flood risk

5.5.1 Canals

Non-natural or artificial sources of flooding can include canals where water is retained above natural ground level. The risk of flooding along a canal is considered to be residual and is dependent on a number of factors. As canals are manmade systems that are heavily controlled, it is unlikely they will respond in the same way as a natural

watercourse during a storm event. Flooding is more likely to be associated with residual risks, similar to those associated with river defences, such as overtopping of canal banks, breaching of embanked reaches or asset (gate) failure as highlighted in Table 5-2. Canals can also have a significant interaction with other sources, such as watercourses that feed them, watercourses into which the canal overflows in times of a flood event (waste weirs) and minor watercourses or drains that cross underneath.

Potential Mechanism	Significant Factors
Leakage causing erosion and rupture of canal lining leading to breach	Embankments Sidelong ground Culverts Aqueduct approaches
Collapse of structures carrying the canal above natural ground level	Aqueducts Large diameter culverts Structural deterioration or accidental damage
Overtopping of canal banks	Low freeboard Waste weirs
Blockage or collapse of conduits	Culverts

Table 5-2 Possible causes of flooding from canals

The risks associated with these events are also dependent on their potential failure location with the consequence of flooding higher where floodwater could cause the greatest harm due to the presence of local highways and adjacent property.

The Lancaster Canal runs north to south down the western edge of the Lune catchment. The River Conder feeds the canal through a side weir and the Glasson Branch of the canal extends westwards from Galgate to Glasson Dock. There is the potential flood risk posed by a breach in the canal substructure, particularly at raised locations.

Data received from the Canal & River Trust (CRT) lists incidents of canal breach or overtopping in the Lancaster District. These incidents are listed in Table 5-3 below.

Date	Type	Location	Comments
04/10/10	Overtopping	Lancaster Canal at Tewitfield	Culvert blockage caused by debris caused overtopping onto towpath and into Whitebeck culvert
08/07/09	Overtopping	Lancaster Canal south of Borwick	Water running into field due to damaged bank protection
02/06/11	Leak	Lancaster Canal near Kellet Lane	Standing water due to leak, repairs required to bank protection
11/11/09	Overtopping	Lancaster Canal at Hall Garth	Embankment erosion allowing overtopping onto the towpath at high water levels
06/09/11	Overtopping	River Conder Feeder	Heavy rainfall caused overtopping of River Conder into feeder channel
26/10/08	Overtopping	River Conder Feeder	High water levels in River Conder coincided with high tide, causing river to overtop into the feeder channel and flood field between river and Conder Feeder

Date	Type	Location	Comments
26/10/08	Overtopping	Between Conder Feeder and Glasson Basin	High water levels due to heavy rainfall combined with inflow from feeder channel caused overtopping at several locations
17/06/11	Overtopping	Glasson Branch at Cliffdale	Overtopping onto towpath caused by water levels being drawn down on main line for maintenance work
19/06/15	Piping leak failure	Lune aqueduct	Leakage observed at the toe of the Lune and Caton Road embankments
05/12/15	Overtopping	Numerous locations	During 5th December 2015 floods, the canal overtopped at various locations
22/11/17	Overtopping	Numerous locations	Flooding and overtopping

Table 5-3 CRT canal breach and overtopping incidents

Any development proposed adjacent to any canal should include a detailed assessment of how a canal breach would impact the site, as part of a site-specific FRA for the development.

5.5.2 Reservoirs

A reservoir can usually be described as an artificial lake where water is stored for use. Some reservoirs supply water for household and industrial use, others serve other purposes, for example, as fishing lakes or leisure facilities. Like canals, the risk of flooding associated with reservoirs is residual and is associated with failure of reservoir outfalls or breaching. This risk is reduced through regular maintenance by the operating authority. Reservoirs in the UK have an extremely good safety record with no incidents resulting in the loss of life since 1925.

The EA is the enforcement authority for the Reservoirs Act 1975 in England and Wales. All large reservoirs must be regularly inspected and supervised by reservoir panel engineers. LAs are responsible for coordinating emergency plans for reservoir flooding and ensuring communities are well prepared. LCiC emergency planners are responsible for coordinating emergency plans for reservoir flooding and ensuring that communities are well prepared.

The EA is the enforcement authority for the Reservoir Act 1975 (reservoirs that hold over 25,000 m^3 of water). The FWMA updated the Reservoirs Act and targeted a reduction in the capacity at which reservoirs should be regulated from 25,000 m^3 to 10,000 m^3. This reduction is, at the time of writing, yet to be confirmed meaning the requirements of the Reservoirs Act 1975 should still be adhered to. The EA ensures that large reservoirs are regularly inspected, and essential safety work is carried out. However, the responsibility for safety lies with the reservoir owners.

There are different requirements for reservoirs that hold 25,000m^3 or more of water above ground level and for reservoirs that hold less than 25,000m^3 of water above ground level. A reservoir must be registered with the EA if it holds, or has the capacity to hold, 25,000 m^3. For reservoirs that contain less than 25,000 m^3 of water, the Reservoir Act does not apply and as a result there is less regulatory control over these smaller reservoirs. Responsibility for maintenance rests with the landowner.

According to the EA Register of Reservoirs, there are five 'large raised reservoirs' directly located within the boundaries of Lancaster or surrounding local authorities. Namely, Abbeystead, Blea Tarn, Damas Ghyll and Langthwaite reservoirs towards the

southern areas of Lancaster and Ingleborough Lake located upstream within the Ribble Valley district.

Whilst large reservoirs provide the obvious source of residual risk (breaching/overtopping) from artificial sources, there could potentially be a number of smaller water bodies within the area. Smaller waterbodies have potential ownership issues resulting in a lack of regularly inspected and poor embankment conditions. This will increase the residual risk of breaching or overtopping associated with them.

Reservoir Flood Map (RFM)

The EA has produced Reservoir Flood Maps (RFM) for all large reservoirs that they regulated under the Reservoirs Act 1975.

The maps show the largest area that might be flooded if a reservoir were to fail and release the water it holds, including information about the depth and speed of the flood waters. In September 2016, the EA produced the RFM guidance 'Explanatory Note on Reservoir Flood Maps for Local Resilience Forums – Version 5[8]' which provides information on how the maps were produced and what they contain.

The large raised reservoirs within Lancaster City Council have the potential to impact areas to the south of the district, such as Dolphinholme and Galgate. The reservoir within the Ribble Valley district has the potential to impact a number of areas within LCiC, including Wennington, Hornby and Caton. Low-lying properties near the coast may also be impacted in the event of a reservoir failure.

The RFM can be viewed nationally at:

https://flood-warning-information.service.gov.uk/long-term-flood-risk/map

The RFM extent shows the worst credible area that is susceptible to dam breach flooding. The map should be used to prioritise areas for evacuation/early warning. It is worth considering that reservoirs within the UK have an extremely good safety record with no incidents resulting in the loss of life since 1925.

If development is proposed downstream of a reservoir, there will need to be an assessment of whether work is needed to improve the design or maintenance of the reservoir. Together with the reservoir undertakers, the LPA should look to avoid an intensification of development within the risk areas and/or ensure that reservoir undertakers can assess the cost implications of any reservoir safety improvements required due to changes in land use downstream of these assets.

The LPA will need to evaluate:

- The potential loss of life and damage to buildings in the event of dam failure,
- How any impounding reservoirs will affect existing flood risk,
- Whether emergency drawdown of the reservoir (reducing the water level) will add to flooding,
- Emergency planning requirements with appropriate officers to ensure safe, sustainable development.

5.6 Historic flooding

LCC provided records of historic flooding within Lancaster which includes flood incidents of multiple sources having occurred across the City. This includes flooding of property, gardens to property, highways and footpaths ranging from June 2017 to March 2021. These incidents have been mapped, however as many of these incidents are at the property level and considered as sensitive information, they have not been included on

[8] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/558441/LIT_6882.pdf

the detailed large scale SFRA maps. They are however shown at the smaller scale of the whole authority in below.

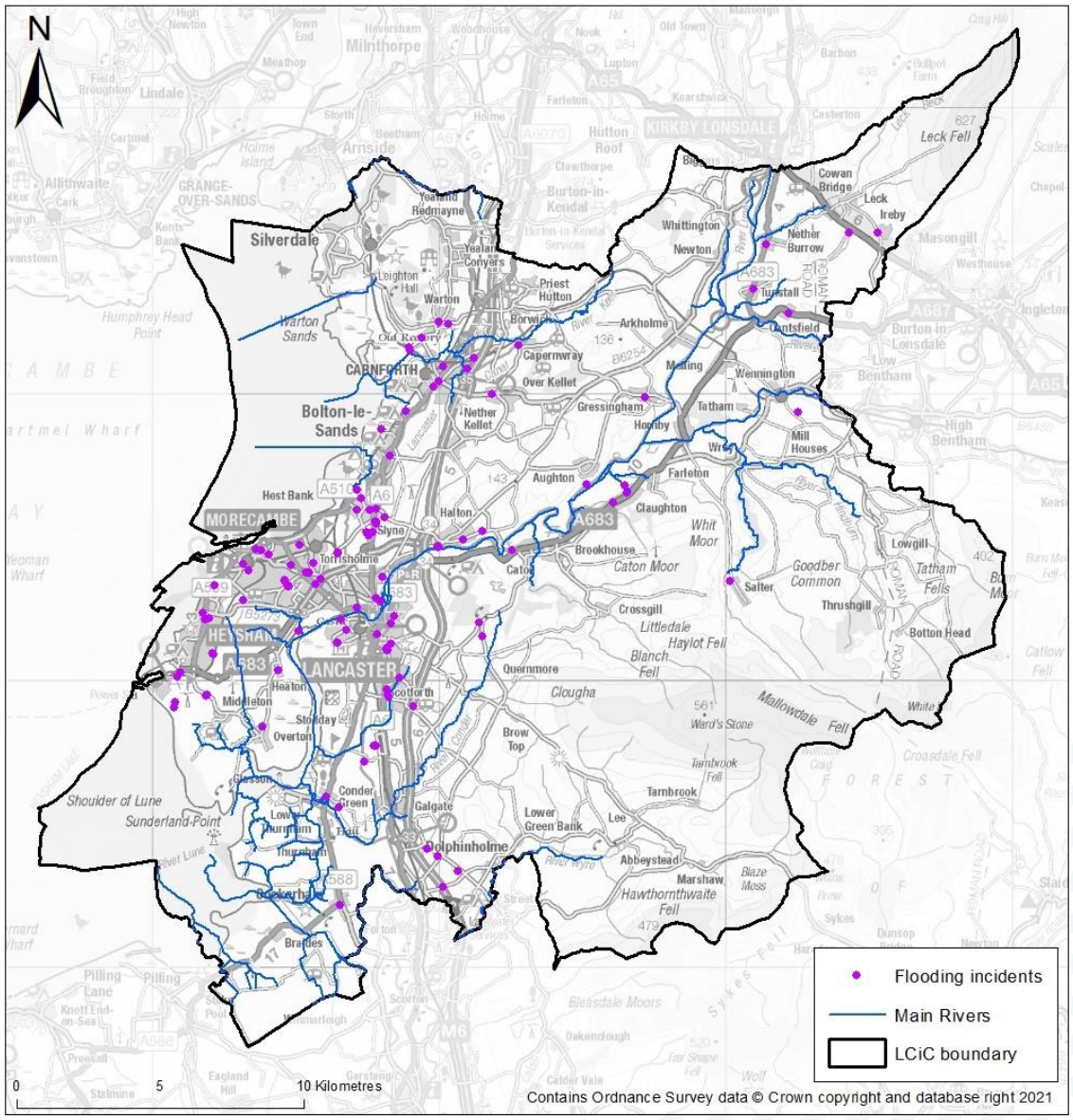

Figure 5-2 LCC historic flood incidents

The LCiC LFRMS and PFRA also summarise historical flood events that have occurred across the City.

5.6.1 Storm Desmond December 2015

In December 2015 Storm Desmond resulted in the highest ever recorded flows on the River Lune, measured at Caton gauging station as exceeding 1,700 cumecs (cubic metres per second). The resulting flooding in and around Lancaster was the most extensive on record. Subsequent analysis, taking these new peak flows into account, has assessed the resulting floods as being between a 1-in-100 year and 1-in-200 year flood. The EA is using this data in the design for future flood defences. After the flood event, surveyors recorded the extent and height of the floods as far as practically possible and have incorporated this data into the Historic Flood Map. The data has not been incorporated into the Flood Map for Planning, which is updated as and when new modelled data is produced.

Coastal, fluvial and flash flooding have all been recognised as significant risks in the Lancaster City Council area as Lancaster is exposed to prevailing south-westerly winds that bring mild, moist air across the Atlantic Ocean. Daily observations from the Lancaster University weather station have been made since 1976. From mid-November through December well over twice the average rainfall fell across northern and western areas from a succession of Atlantic storms

A 2-day rainfall total of 82mm was recorded during Storm Desmond, this is the highest two-day value in the station's history, and the rainfall amount of 60mm which fell between 0900 GMT on 5 December and 0900 GMT on 6 December is the second highest on record for a 24 hour period at this station (the highest being 69mm on 8 December 1983). This record-breaking 2-day event followed the wettest November on record at Hazelrigg, which had more than twice the monthly average rainfall (250mm; 213% of average) and also marked the end of an exceptionally wet 5-week period that contained only 5 dry days.

Recovery and funding

The EA's flood defences protected over 12,500 properties during Storm Desmond. However, the Riverside Park and Lansil Industrial Estates off Caton Road flooded directly from the River Lune. An electricity sub-station was inundated causing a power cut which affected 55,000 people in Lancaster and Morecambe. To reduce flood risk for the future and prepare for sustainable development, LCiC and the EA, in collaboration with communities and businesses have worked to ensure for better protection against future flooding. New flood defences along the River Lune were completed in January 2021 that will reduce the risk of flooding. The electricity sub-station has since been rebuilt and raised above the ground by Electricity North West Limited. This will significantly reduce the risk of it being inundated in the future.

LCiC made payments over £66,500 to 133 people in the district using funding from central Government. Properties flooded as a result of Storm Desmond were exempt from council tax for a minimum of three months. Businesses could also apply for an exemption for paying business rates, between 3–12 months depending on when the property is re-occupied[9]. Then Prime Minister David Cameron also provided £2.3bn investment to protect 300,000 houses across the country and more than £40m was given to fix those defences overwhelmed by the record rainfall in December 2015 and to make them more resilient to further bad weather. This target has now been achieved and £5.2 billion is to be provided to better protect 336,000 properties in England by 2027.

Furthermore, in September 2016, the National Flood Resilience Review awarded a further £12.5 million to the EA and £750,000 to the Fire and Rescue Services to be spent on preparing the country for extreme flooding events. At the time of writing, the EA has five times more temporary flood barriers than winter 2015[10].

Flood Risk Management for the future

Storm Desmond was an unprecedented event nevertheless, LCiC along with the EA, Government and partners have worked to ensure for better protection against future flooding. LCoC as LLFA reviewed the 2015 Surface Water Management Plan (SWMP) (level 2) for Lancaster District and therefore proposed areas for deeper investigation leading to investment in improvement schemes.

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9 Lancaster City Council. (2016). Financial assistance for flood victims. [online] Available at: https://www.lancaster.gov.uk/news/2016/jan/financial-assistance-for-flood-victims [last updated March 2016].

10 Environment Agency. (2016), How the Environment Agency and partners responded to the flooding of winter 2015, and action plans to protect affected communities. Flood recovery: action plans for flood-hit communities.

- Following the event, all relevant flood risk management authorities carried out a preliminary review of any flood risk related assets, public infrastructure and/or flood defences which were likely to have been significantly impacted with the flooding. No such assets have been identified within the Lancaster community.
- All relevant flood risk management authorities have met to discuss the primary flood mechanisms and the impacts this had on the community. The LLFA encourages any concerned residents to consider installing Property Flood Resilience (PFR) measures in order to further reduce the impact of flood water entering their property in the future.
- Since November 2016, all relevant risk management authorities have met to discuss the primary flood mechanisms and the impacts that the flooding has had on this community. It has since been concluded that further action will be required in response to this flood event. This includes a site-specific investigation to gain a better understanding of the local issues which was undertaken for Lancaster. The draft Lancaster Surface Water Management Plan arose from this although it is, at the time of writing, due to be published late 2021.

5.6.2 Lancashire Fire and Rescue Service flood incident data

Lancashire Fire and Rescue Service (LFRS) provided a spatial dataset containing flooding incident locations that LFRS has attended over the period 2011 to 2020. LFRS do not plot the extents of any flooding or each and every property affected by flooding during spate conditions, the incident plot is centred on the flooding location. There are also many different types of flooding incidents included, such as leaks in homes, to rivers breaching and subsequent flooding of properties. It was therefore decided not to include this data on the SFRA Maps. Incidentally, there were 89 flood incidents recorded by LFRS over this period, across Lancaster district.

5.6.3 Historic surface water and sewer flooding

United Utilities maintain a spatial flood incident register which is used to record flood incidents at the individual property, street or road level attributable to water company-controlled sewer networks, whether that be from foul and / or surface water sewers.

United Utilities provided the flood incident register for use in this SFRA, including both internal and external property flood incidents. The internal incident dataset is from 2009 to 2019; and the external incident dataset from 2009 to 2018. Due to the sensitivity of this information, this data could not be presented at the local level as part of this SFRA. However, the data has been aggregated into Wards to gain some insight into where sewer flood incidents may be more prevalent, as shown in Figure 5-3.

The Wards with the highest number of historic sewer flooding incidents include Bolton and Slyne, Heysham Central and Heysham North. Some caution should be applied when viewing this data in that not all historic incidents may have been recorded.

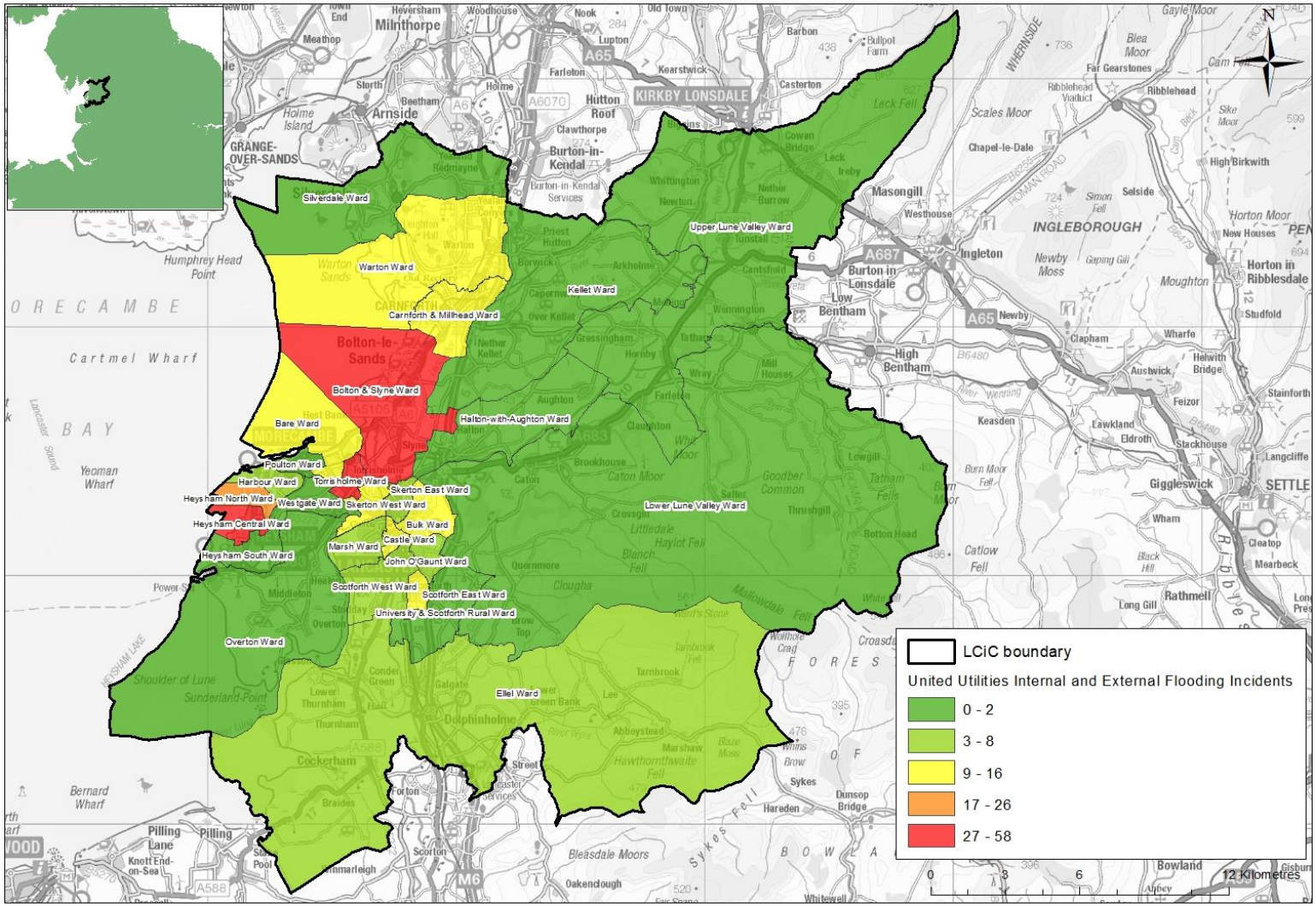

Figure 5-3 Number of United Utilities Internal and External historic flooding incidents per ward

5.6.4 EA Historic Flood Map

The Historic Flood Map (HFM) is a spatial dataset showing the maximum extent of all recorded historic flood outlines from river, sea and groundwater, and shows areas of land that have previously been flooded across England. Records began in 1946 when predecessor bodies to the EA started collecting information about flooding incidents. The HFM accounts for the presence of defences, structures, and other infrastructure where such existed at the time of flooding. It includes flood extents that may have been affected by overtopping, breaches or blockages. It is also possible that historic flood extents may have changed and that some areas would not flood at present i.e. if a flood defence has been built.

The HFM does not contain any information regarding flood source, return period or date of flooding, nor does the absence of the HFM in an area mean that the area has never flooded, only that records of historic flooding do not exist. The Recorded Flood Outlines (RFO) dataset however does include details of flood events. The difference between the two datasets is that the HFM only contains flood outlines that are 'considered and accepted' by the EA following adequate verification using certain criteria. For those areas not within an HFM or RFO outline, this does not mean these areas have never flooded, only that the EA does not have records of flooding in this area.

There are several flood incidents within the HFM in the District, shown on the SFRA Maps in Appendix A. There are incidents of fluvial flooding from the River Lune in Lancaster, Caton and Tunstall, and the River Wenning at Hornby, and tidal flooding in Morecambe and around Cockerham. There are also historic flood incidents recorded at Millhead near the River Keer.

5.7 Flood risk management

The aim of this section of the SFRA is to identify existing Flood Risk Management (FRM) assets and previous / proposed FRM schemes. The location, condition and design standard of existing assets will have a significant impact on actual flood risk mechanisms. Whilst future schemes in high flood risk areas carry the possibility of reducing the probability of flood events and reducing the overall level of risk. Both existing assets and future schemes will have a further impact on the type, form and location of new development or regeneration.

5.7.1 EA inspected assets (Spatial Flood Defences dataset)

The EA maintains a GIS dataset called the Spatial Flood Defences dataset. This national dataset contains such information as:

- Asset type (flood wall, embankment, high ground, demountable defence, bridge abutment);
- Flood source (fluvial, tidal, fluvial and tidal combined);
- Design Standard of Protection (SoP);
- Asset length;
- Asset age;
- Asset location; and
- Asset condition.

See Figure 5-4 for condition assessment grades using the EA's Condition Assessment Manual[11] (CAM).

[11] Environment Agency. (2012). Visual Inspection Condition Grades. In: EA Condition Assessment Manual. Bristol: Environment Agency. p9.

The design standard of protection (SoP) for a flood defence is a measure of how much protection a flood defence gives. If the SoP is 100, the defence protects against a flood with the probability of occurring once in 100 years.

Grade	Rating	Description
1	Very Good	Cosmetic defects that will have no impact on performance
2	Good	Minor defects that will not reduce the overall performance of the asset
3	Fair	Defects that could reduce the performance of the asset
4	Poor	Defects that would significantly reduce the performance of the asset. Further investigation needed.
5	Very Poor	Severe defects resulting in complete performance failure.

Figure 5-4 EA flood defence condition assessment grades

Defence Location	Asset Type	Flood Source	Watercourse	Design Standard	Bank	Condition
Hornby	Wall	Fluvial	River Wenning	75	Left	3
Millhead	Embankment	Fluvial	River Keer	40	Right	3
Millhead	Wall	Tidal	-	25	Left	3
Farleton	Embankment	Fluvial	Farleton Beck	80	Both	4
Claughton	Embankment	Fluvial	Claughton Beck	80	Left	3
Lancaster	Wall	Tidal	River Lune	25	Right	3
Lancaster	Walls	Tidal	River Lune	Ranging from 50-500	Left	Ranging from 2-4
Lancaster	Embankment	Tidal	River Lune	500	Left	3
Lancaster	Embankment	Tidal	River Lune	20	Left	3 (past breaches have occurred)
Heaton	Embankment	Tidal	River Lune	25	Right	3
Galgate	Wall	Fluvial	River Conder	100	Both	3

Defence Location	Asset Type	Flood Source	Watercourse	Design Standard	Bank	Condition
Conder Feeder	Embankments	Fluvial	River Conder	Ranging from 20-100	Both	Ranging from 3-4
Glasson	Wall	Tidal	-	200	-	3
Glasson	Embankment	Tidal	-	200	-	3

Table 5-4 Major flood defences

In total, there are 412 flood defence assets within the district, according to the EA's Spatial Flood Defence dataset. Table 5-4 highlights the main locations within the District that have significant FRM assets, the majority of which are located close to Lancaster City Centre, Glasson and Carnforth.

Of the 255 constructed fluvial flood defence assets within the district, 216 are areas of raised ground, 17 are floodwalls and 22 are flood embankments. The floodwalls aim to prevent the flooding of residential and commercial properties and infrastructure. There are nine areas of raised ground defences within the district, that have been assessed at condition grade 4 meaning the condition is rated as 'Poor' according to the CAM (as discussed in Figure 5-4) meaning that there are defects that would significantly reduce the performance of the asset and further investigation is required.

Of the 157 constructed coastal/tidal flood defence assets, 70 are flood embankments, 56 are flood walls, 16 are areas of raised ground and 15 are flood gates. Ten flood walls near Morecambe were assessed at condition grade 4 meaning the condition was rated as 'Poor' according to the CAM meaning that there are defects that would significantly reduce the performance of the asset and further investigation is required. The Morecambe defences have now been replaced with the Wave Reflection Wall.

Coastal flood defences rated at condition grades 4 or 5 fall between Heysham and Hest Bank. The SMP2 indicates a 'hold the line' management approach should be taken along this section of coastline. Therefore, these defences need investment to maintain the standard of protection provided by the existing defence line. If defences rated as 'Poor' or 'Very Poor' aren't repaired and continue to deteriorate, this could lead to a breach of the defence and potentially cause flooding to properties that the flood defence assets were constructed to protect.

As well as the ownership and maintenance of a network of formal defence structures, the EA carries out a number of other flood risk management activities that help to reduce the probability of flooding, whilst also addressing the consequences of flooding. These include:

- Maintaining and improving existing flood defences, structures and watercourses.
- Enforcement and maintenance where riparian owners carry out work that may be detrimental to flood risk.
- Identifying and promoting new Flood Risk Management Schemes were appropriate.
- Working with local authorities to influence the location, layout and design of new and redeveloped property and ensuring that only appropriate development is permitted relative to the scale of flood risk.
- Operation of Floodline Warnings Direct and warning services for areas within designated Flood Warning Areas (FWA) or Flood Alert Areas (FAA). EA FWAs are shown on the SFRA Maps in Appendix A.

- Promoting awareness of flooding so that organisations, communities and individuals are aware of the risk and therefore sufficiently prepared in the event of flooding.
- Promoting resilience and resistance measures for existing properties that are currently at flood risk or may be in the future as a result of climate change.

5.7.2 EA Areas Benefitting from Defences (ABD)

Alongside the Spatial Flood Defences dataset discussed above, the EA also publishes a spatial dataset showing the areas that benefit from major flood defences. ABDs show those areas that would benefit from the presence of defences in a 1% AEP fluvial or 0.5% AEP tidal flood event. The ABDs present within the District are included on the SFRA maps in Appendix A and are also listed in Table 5-5.

Area Impacted	Unitary ward	Sites impacted	Area (km2)	NGR
Millhead, near Main Street	Warton Ward / Carnforth & Millhead Ward	-	0.1	SD4954327148
Cragg Bank Lane, near Carnforth	Carnforth & Millhead Ward	-	0.5	SD4877970455
Coastal Road, near Bolton Town End	Bolton & Slyne Ward	-	0.5	SD4763267456
Marine Road East, near Morecambe	Poulton Ward	-	0.1	SD4437964889
New Quay Road, near Lancaster	Marsh Road	-	0.8	SD4633562062
A683, near Heysham	Overton Ward / Heysham South Ward	-	8.1	SD4309160583
Lancaster Road, near Cockerham	Ellel Ward	-	15.9	SD4562351532

Table 5-5 ABDs within LCiC boundary

The EA only maps defended areas that offer protection against a 1% AEP fluvial or 0.5% AEP tidal event, as required by the NPPF. This does not mean that only these areas are defended, but that other areas where defences may be present will have a lower standard of protection.

5.7.3 LLFA assets and future flood risk management schemes

The LLFA owns and maintains a number of assets throughout the District which include culverts, bridge structures, weirs, gullies, manholes, grids and trash screens. The majority of these assets will lie along ordinary watercourses within smaller urban areas where watercourses may have been culverted or diverted, or within rural areas. All these assets can have flood risk management functions as well as an effect on flood risk if they become blocked or fail. In most cases responsibility lies with the riparian / landowner.

The LLFA, under the provisions of the FWMA, has a duty to maintain a register of structures or features that have a significant effect on flood risk, including details of

ownership and condition as a minimum. The Asset Register should include those features relevant to flood risk management function including feature type, description of principal materials, location, measurements (height, length, width, diameter) and condition grade. The Act places no duty on the LLFA to maintain any third-party features, only those for which the authority has responsibility as land/asset owner.

Based on information publicly available from LCoC, there are a number of ongoing and proposed flood risk management work programmes in the district. At the time of writing, ongoing works include the Lancaster Phase 4 Mill Race and Surface Water Study (due for completion 2021) to understand the flooding mechanism, rather than on-the-ground works, and also the Warton Mires Partnership project with the Royal Society for the Protection of Birds (RSPB) (due for completion Autumn 2024).

5.7.4 EA flood risk management activities and Flood and Coastal Erosion Risk Management research and development

The FCERM Research and Development programme is run by the EA and Defra and aims to serve the needs of all flood and coastal operating authorities in England. The programme provides the key evidence, information, tools and techniques to:

- Inform the development of FCERM policy and strategy.
- Understand and assess coastal and flood risk and the processes by which these risks arise.
- Manage flood and coastal erosion assets in a sustainable way.
- Prepare for and manage flood events effectively.
    - The current 6-year FCERM investment programme ran from 1 April 2015 to 31 March 2021 and is therefore due for update. The EA regularly reviews the programme to take into account changes such as:
- Serious flooding.
- Local partnership funding contributions.
- New flood risk information.

We develop projects to reduce flooding and coastal erosion by working with:

- Local authorities.
- Internal drainage boards.
- Local communities.

Follow the link below for the latest news:

https://www.gov.uk/government/publications/national-flood-and-coastal-erosion-risk-management-strategy-for-england--2

The ongoing works in the district, at the time of writing, associated with the FCERM Development Programme include:

- Flood risk management scheme to build new defences along the banks of the River Lune at Caton Road, Lancaster. Scheme to protect 40 dwellings and employment sites. Completed in 2021. Phase 3A project being worked on in which a community pumping station linked with water attenuation with anticipated delivery 2021-22.

5.7.5 Water company assets

The sewerage infrastructure within the district is likely to be based on Victorian sewers from which there may be a risk of localised flooding associated with the existing drainage capacity and sewer system. UU is responsible for the management of the adopted sewerage systems in the district, including for surface water and foul sewage. Private foul and surface water sewers may exist as only those connected to the public

sewer network prior to 1st July 2011 were transferred to the water companies under the Private Sewer Transfer in October 2011 if they met certain criteria. In addition, there are likely to have been sewers and drains constructed since this transfer date which have not been offered for adoption or have not met the requirements of a Section 104 adoption agreement and therefore these remain private too. Surface water sewers discharging to watercourses were not part of this transfer and would therefore not be under the ownership of the sewerage undertaker, unless they were offered for adoption either at the time of construction under a Section 104 agreement or retrospectively under a Section 104 adoption agreement.

Water company assets include Wastewater Treatment Works, Combined Sewer Overflows, pumping stations, detention tanks, sewer networks and manholes.

5.7.6 Natural Flood Management / Working with Natural Processes

Natural flood management (NFM) or Working with Natural Processes (WwNP) is a type of flood risk management used to protect, restore and re-naturalise the function of catchments and rivers to reduce flood and coastal erosion risk. WwNP has the potential to provide environmentally sensitive approaches to minimising flood risk, to reduce flood risk in areas where hard flood defences are not feasible and to increase the lifespan of existing flood defences. NFM and WwNP are used interchangeably in the UK though the term WwNP will be used throughout this report.

A wide range of techniques can be used that aim to reduce flooding by working with natural features and processes in order to store or slow down flood waters before they can damage flood risk receptors (e.g. people, property, infrastructure, etc.). WwNP involves taking action to manage flood and coastal erosion risk by protecting, restoring and emulating the natural regulating functions of catchments, rivers, floodplains and coasts.

Government is actively encouraging the implementation of WwNP measures within catchments and coastal areas in order to assist in the delivery of the requirements of various directives relating to broader environmental protection and national policies. WwNP implementation across the UK should be considered a fundamental consideration or component of the flood risk management tool kit.

Evidence base for WwNP to reduce flood risk

The EA has produced the WwNP evidence base which includes three interlinked projects:

- Evidence directory
- Mapping the potential for WwNP
- Research gaps

The evidence base can be accessed via:

https://www.gov.uk/government/publications/working-with-natural-processes-to-reduce-flood-risk

The evidence base can be used by those planning projects which include WwNP measures to help understand:

- Their potential FCRM benefits and multiple benefits
- Any gaps in knowledge
- Where it has been done before and any lessons learnt
- Where in a catchment they might not be most effective.

The evidence directory presents the evidence base, setting out the scientific evidence underpinning it. Its purpose is to help flood risk management practitioners and other responsible bodies access information which explains what is known and what is not

about the effectiveness of the measures from a flood risk perspective. There is also a guidance document which sits alongside the evidence directory and the maps which explains how to use them to help make the case for implementing WwNP when developing business cases.

Mapping the potential for WwNP

The JBA Trust has worked with Lancaster Environment Centre (LEC) to produce an interactive catalogue of nature-based flood risk management projects in the UK. This map includes a catalogue of projects where WwNP is being applied on the ground or being considered as an option to reduce flood risk. Additionally, the map includes a set of layers that indicates the potential areas where WwNP would be beneficial based on research by the EA. The interactive map is available via this link:

https://naturalprocesses.jbahosting.com/

JBA Consulting has also been working with the EA and LEC to update national maps of the potential for WwNP. LEC has developed a new spatial model of slowly permeable soils to identify areas where shrub or tree-planting could increase hydrological losses and slow the flow based on BGS 1:50k scale maps. The maps are available under open government license. The national maps make use of different mapping datasets and highlight potential areas for tree-planting (for three different types of planting), runoff attenuation storage, gully blocking and floodplain reconnection. The maps can be used to signpost areas of potential and do not take into account issues such as land-ownership and drainage infrastructure, but they may well help start the conversation and give indicative estimates of, for example, additional distributed storage in upstream catchments.

These maps are intended to be used alongside the evidence directory to help practitioners think about the types of measure that may work in a catchment and the best places in which to locate them. There are limitations with the maps, however it is a useful tool to help start dialogue with key partners. The WwNP types are listed in Figure 5-5.

WWNP Type	Open data licence details
Floodplain reconnection	• Risk of Flooding from Rivers and Seas (April 2017) • Data derived from the Detailed River Network, which is not displayed, rescinding the licence requirements for displaying the dataset (to be superseded by OS Water Network but not available for project in time). • Constraints data
Run-off attenuation features	• Data derived from Risk of Flooding from Surface Water (Depth 1 percent annual chance and Depth 3.3 percent annual chance) (October 2013). The original data is not displayed, due to licensing restrictions.[2] • Constraints data • Gully blocking potential (a subset of run-off attenuation features on steeper ground) • Data derived from OS Terrain 50 (2016) to classify each run-off attenuation feature based on median slope.
Tree planting (3 categories)	• Floodplain: Flood Zone 2 from Flood Map for Planning (April 2016) and new constraints layer • Riparian: 50m buffer OS water features from Section 2.2.3 with constraints layer • Wider catchment woodland: - Based on slowly permeable soils. - BGS Geology 50,000 Superficial and Bedrock layers (both V8, 2017). Used with new science to derive new 100m gridded open data. This new layer can be used to signpost areas of SLOWLY PERMEABLE SOILS and can be checked in more detail on the BGS portal. - To the north of the line of Anglian glaciation, the presence of till-diamicton has been shown to be a strong predictor of slowly permeable soils. - To the south of this line, particular bedrock geologies have shown a similarly strong spatial relationship to the presence of slowly permeable soils.

Figure 5-5 WwNP measures and data[12]

The WwNP datasets are included on the SFRA Maps in Appendix A and should also be used to highlight any sites or areas where the potential for WwNP should be investigated further as a means of flood mitigation. Proposed development should not jeopardise these opportunities:

- Floodplain Reconnection:
  - Floodplain Reconnection Potential – areas of low or very low probability based on the Risk of Flooding from Rivers and Sea dataset (see Section

[12]https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/677592/Working_with_natural_processes_mapping_technical_report.pdf

5.2.4), which are in close proximity to a watercourse and that do not contain properties, are possible locations for floodplain reconnection. It may be that higher risk areas can be merged, depending on the local circumstances.

- Runoff Attenuation Features (runoff attenuation features are based on the premise that areas of high flow accumulation in the RoFSW) maps are areas where the runoff hydrograph may be influenced by temporary storage if designed correctly):
  - Runoff Attenuation Features 1% AEP
  - Runoff Attenuation Features 3.3% AEP
- Tree Planting:
  - Floodplain Woodland Potential and Riparian Woodland Potential – woodland provides enhanced floodplain roughness that can dissipate the energy and momentum of a flood wave if planted to obstruct significant flow pathways. Riparian and floodplain tree planting are likely to be most effective if close to the watercourse in the floodplain, which is taken to be the 0.1% AEP flood extent (Flood Zone 2), and within a buffer of 50 metres of smaller watercourses where there is no flood mapping available. There is a constraints dataset that includes existing woodland.
  - Wider Catchment Woodland Potential – slowly permeable soils have a higher probability of generating 'infiltration-excess overland flow' and 'saturation overland flow'. These are best characterised by gleyed soils, so tree planting can open up the soil and lead to higher infiltration and reduction of overland flow production.

Limitations

The effectiveness of WwNP measures is site-specific and depends on many factors, including the location and scale at which they are used. It may not always be possible to guarantee that these measures alone will deliver a specified standard of defence. Consequently, flood risk management measures should be chosen from a number of options ranging from traditional forms of engineering through to more natural systems. The research gaps that need to be addressed to move WwNP into the mainstream are identified in the evidence directory.

WwNP in Lancaster

In Lancaster, the benefits of introducing more areas of green infrastructure such as parks, green roofs and street trees, are the reduction of surface run off by increasing infiltration and also slowing down the rate at which rainfall reaches the ground via interception[13].

Over the past two years, The Woodland Trust has led a project which resulted in the planting of 62,000 new trees on Tebay Common in Cumbria. This project aims to slow down the water that runs off the common and into the Lune at times of high rainfall, ultimately reducing the effect in Lancaster. This project will not only help to reduce flooding, but also will increase biodiversity on land and in the river with more fish and birds. Greater biodiversity is important, especially after many rural areas were negatively impacted by Storm Desmond.

Lancaster University - An extensive array of swales, ponds and underground tanks with restricted outflows, designed to intercept and gradually release runoff from high rainfall events in order to prevent both onsite and offsite flood events – ongoing project.

[13] Forest Research. 2010Benefits of green infrastructure. Report by Forest Research. Forest Research: Farnham, UK

Throughout Wyre River Catchment (Including Upper Wyre at Abbeystead) - The use of natural flood management, including the building of leaky dams, the creation of bog, and the rewetting of peat, on 70 hectares of the River Wyre catchment by the Rivers Trust to help reduce the frequency of flooding for a number of properties. At the same time as reducing flood risk, these natural flood management schemes will create new habitats for wildlife and help to mitigate climate change through the storage of greenhouse gases in the newly created wetlands and peatlands.

Galgate Slow the Flow Project - This Slow the Flow project is delivering Natural Flood Management measures in the sub-catchments of Whitley Beck and Burrow Beck and tributaries that focus on protecting Galgate and South Lancaster. Interventions on the ground include hedge planting and fencing, the creation of a retention pond, sward lifting, and installation of leaky dams. Lune Rivers Trust are leading this work with the guidance and supervision of the Slow the Flow Board. – currently in development.

Claver Hill - Slow the flow and holistic water management scheme to manage the seasonal flooding we have experienced over the last several years. We are doing this water work in partnership with the Lune Valley Trust and Rod Everett of Backsbottom Farm – 2021-24.

Lancashire Woodland Trust - Planting 10,000 trees per year throughout the Lune Catchment.

6 Development and flood risk

6.1 Introduction

This section of the SFRA discusses how flood risk should be considered in development management. Appendix B and C provide a review, relative to flood risk, of LCiC's 37 Local Plan allocations. The SFRA will be used to assess the change in risk since the 2017 SFRA and allocation and where an Exception Test will be required at planning application stage.

6.2 The sequential approach

The FRCC-PPG provides the basis for the Sequential Approach. It is this approach, integrated into all stages of the development planning process, which provides the opportunities to reduce flood risk to people, property, infrastructure and the environment to acceptable levels.

The approach is based around the FRM hierarchy, in which actions to avoid, substitute, control and mitigate flood risk is central. For example, it is important to assess the level of risk to an appropriate scale during the decision-making process, (starting with this Level 1 SFRA). Once this evidence has been provided, positive planning decisions can be made and effective FRM opportunities identified.

Figure 6-1 illustrates the FRM hierarchy with an example of how these may translate into each authorities' management decisions and actions.

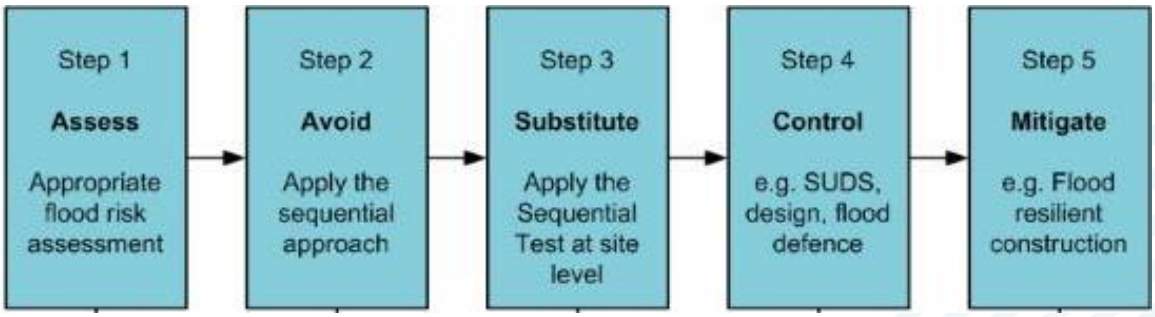

Figure 6-1: Flood risk management hierarchy

Using the EA's Flood Map for Planning, the overall aim of the Sequential Approach should be to steer new development to low risk Flood Zone 1. Where there are no reasonably available sites in Flood Zone 1, the flood risk vulnerability of land uses and reasonably available sites in Flood Zone 2 should be considered, applying the Exception Test if required.

Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in higher risk Flood Zone 3, be considered. This should take into account the flood risk vulnerability of land uses and the likelihood of meeting the requirements of the Exception Test if required.

There are two different aims in carrying out the Sequential Approach depending on what stage of the planning system is being carried out i.e. LPAs allocating land in Local Plans or determining planning applications for development. This SFRA does not remove the need for a site-specific Flood Risk Assessment at a development management stage.

Appendix C provides a guided discussion on why and how the Sequential Approach should be applied, including the specific requirements for undertaking Sequential and Exception Testing.

6.3 Sustainability Appraisal (SA) and flood risk

The Sustainability Appraisal of the Local Plan should help to ensure that flood risk is taken into account at all stages of the planning process with a view to directing development away from areas at flood risk, now and in the future, by following the sequential approach to site allocation. The SA should be informed by this SFRA so that flood risk is fully taken into account in the preparation of plan policies, including policies for flood risk management to ensure that flood risk is not increased (para 010 FRCC-PPG).

Detailed consideration of site layout and design can avoid those parts of a site at flood risk, the Council would be demonstrating a sustainable approach to development (see Appendix B and C for sites assessment).

In terms of surface water, the same approach should be followed whereby those sites at highest risk should be avoided or site layout should be tailored to ensure sustainable development. This should involve investigation into appropriate SuDS techniques (see Section 0).

Surface water flood risk should be considered with the same importance as fluvial flood risk.

6.4 Cumulative impacts

The NPPF (2021) states that strategic policies…

"…should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards". (para 160)

Previous policies have relied on the assumption that if each individual development does not increase the risk of flooding, the cumulative impact will also be minimal. However, if there is a lot of development occurring within one catchment, particularly where there is flood risk to existing properties or where there are few opportunities for mitigation, the cumulative impact may be to change the flood response of the catchment.

Consideration should be given to the following:

- The importance of phasing of development, as discussed in Section 6.4.4;
- Cross boundary impacts i.e. there should be dialogue between LCiC and neighbouring authorities upstream, particularly Craven, in terms of decisions taken on upstream development, flood risk management practices and capital works (see Section 6.4.1);
- Leaving space for floodwater, utilising greenspace for flood storage and slowing the flow (see Sections 6.4.2 and 5.7.6); and
- SuDS and containment of surface water onsite as opposed to directing elsewhere (Section 6.7).

All new development plans must comply with the NPPF and demonstrate flood risk will not be increased elsewhere. Therefore, providing all new development complies with the latest guidance and legislation relating to flood risk and sustainable drainage, in theory there should not be any increase in flood risk downstream.

Strategic solutions may include upstream flood storage, integrated major infrastructure/ Flood Risk Management schemes, new defences, and watercourse improvements as part of regeneration and enhancing green infrastructure, with opportunities for Working with Natural Processes and retrofitting of SuDS to existing development.

According to the NPPF, the LPA should work with neighbouring authorities to consider strategic cross boundary issues and infrastructure requirements. Local authorities also have a duty to cooperate whereby councils work together on strategic matters and produce effective and deliverable policies on strategic cross boundary matters.

6.4.1 Hydrological linkages and cross boundary issues

Lancaster City Council is a largely rural district with compact urban areas therefore any large-scale development in the Wyre (Upper) and Cocker (Lune) catchments could have a significant impact on flow regimes and subsequent flood risk in downstream authority areas, namely Wyre district.

Figure 6-2 illustrates fluvial hydraulic linkages for the catchments in and around the district. The district receives the River Lune from South Lakeland, and both the River Wenning and River Greta from Craven authority area; upstream land use changes in these authority areas could have an effect on fluvial flood risk along these watercourses. The River Wyre originates within Lancaster District and flows directly into the Wyre district. It is important that the strategic solutions stated above are fully considered in development planning in these catchments, to ensure there are no adverse effects on flood risk in the downstream authority of Wyre.

Were these strategic solutions not considered in upstream development planning, the following issues may occur:

- Reduction in upstream floodplain storage capacity; and
- Increase in impermeable areas leading to a reduction in rainfall infiltration and subsequent increased runoff.

These issues highlight the importance of the NYFRP and the need to work together on flood risk management, particularly where actions could exacerbate flooding in downstream communities. The need for consistent regional development policies controlling runoff or development in floodplains within contributing districts is therefore crucial as this would have wider benefits for Lancashire authorities as a whole as well as Lancaster City Council. Appropriate flood risk management policies will be required in the Local Plan.

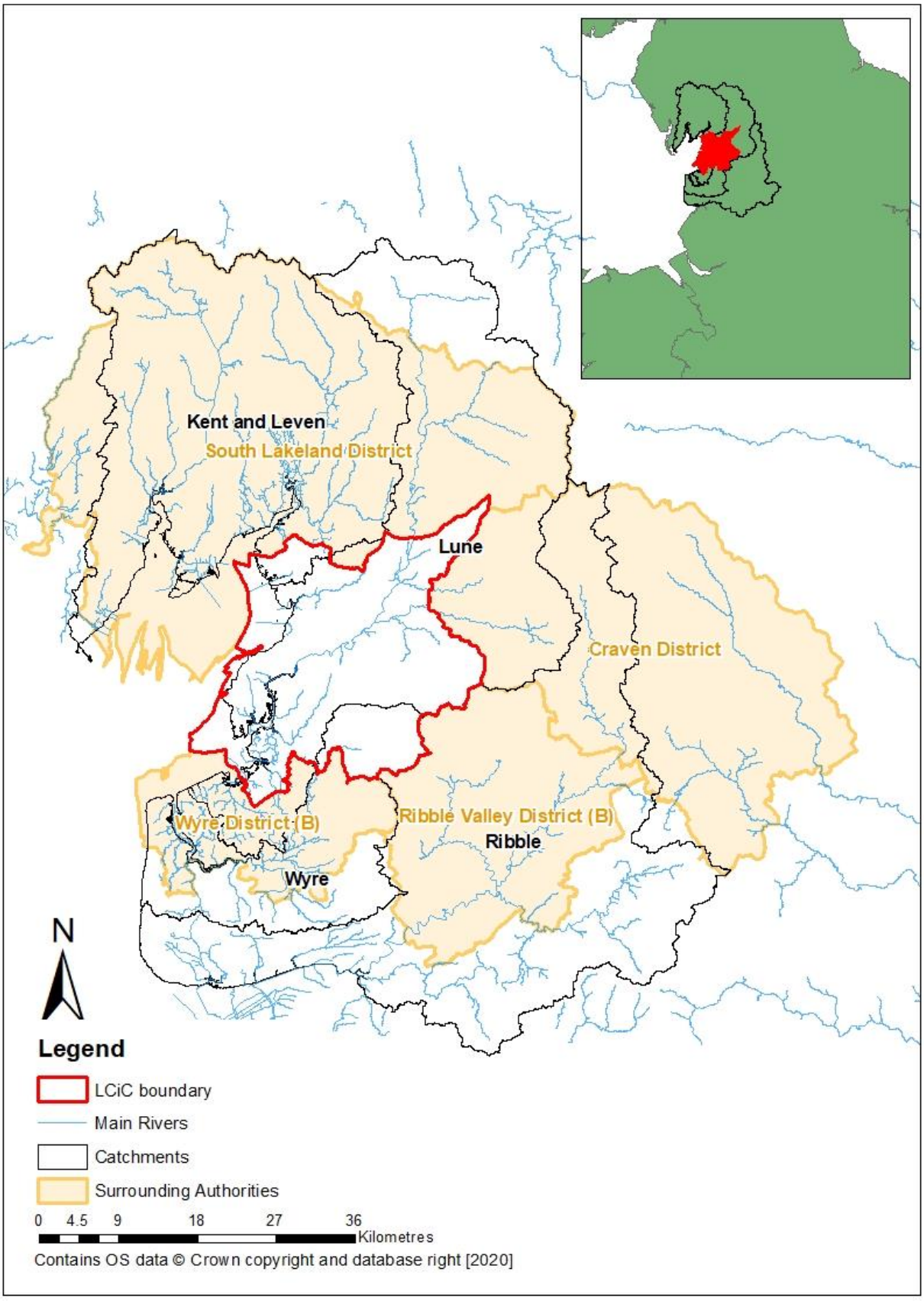

Figure 6-2: Fluvial hydraulic linkages for catchments in and around the District

6.4.2 Cumulative impact of development and strategic solutions

This section provides a summary of the catchments with the highest flood risk and development pressures and then makes recommendations for local planning policy based on these.

Introduction

Under the NPPF, strategic policies and their supporting SFRAs, are required to 'consider cumulative impacts in, or affecting, local areas susceptible to flooding' (para. 160), rather than just to or from individual development sites.

When allocating land for development, consideration should be given to the potential cumulative impact of the loss of floodplain storage volume, as well as the impact of increased flows on flood risk downstream. Whilst the loss of storage for individual developments may only have a minimal impact on flood risk, the cumulative effect of multiple developments may be more severe. The NPPF requires that plans should manage risk by 'using opportunities provided by new development to reduce the causes and impacts of flooding'.

All developments are required to comply with the NPPF and demonstrate they will not increase flood risk elsewhere. Therefore, providing developments comply with the latest guidance and legislation relating to flood risk and sustainable drainage, in theory they should not increase flood risk downstream.

Catchments within the study area that have the potential to influence existing flood risk issues in neighbouring local authorities were identified, as well as catchments in the study area that may be influenced by development in catchments in neighbouring local authorities. Historic flood incidents, the current and potential increases in surface water flood risk to properties and cross boundary issues in each catchment were assessed to identify the catchments at greatest risk.

Local planning policies can also be used to identify areas where the potential for development to increase flood risk is highest and identify opportunities for such new development to positively contribute to decreases in flood risk downstream.

Strategic solutions

LCiC have a vision for the future management of flood risk and drainage in the authority area. This concerns flood risk management, alongside wider environmental and water quality enhancements. Strategic solutions may include upstream flood storage, integrated major infrastructure/FRM schemes, new defences and watercourse improvements as part of regeneration and enhancing green infrastructure, with opportunities for natural flood management and retrofitting sustainable drainage systems.

The list below summarises the key outcomes the strategic plans for the district are seeking to achieve.

The strategic policy vision from the CFMP and RBMP focuses on safeguarding the floodplain from inappropriate development and encouraging collaboration and creating new partnerships to reduce the risk of flooding and to enhance the natural environment. Within Lancaster district, strategic solutions encourage development to:

- Deliver effective local Flood Risk Management to comply with new and revised legislation, national policies, standards, and guidance. This includes revising policies on regulating Ordinary Watercourses, managing flood risk and coastal erosion, and developing a new Highway Drainage Connection policy;
- Understand local risks and challenges by working with partner organisations and communities to identify the causes and effects of local flooding, through delivering any outstanding Surface Water Management Plans and bidding for funding to improve understanding of groundwater flooding and opportunities for natural flood management;

- Support sustainable flood resilient development through avoiding development in existing and future areas at risk of flooding and coastal erosion and managing other land elsewhere to avoid increasing the risks, through the encouragement of the implementation of SuDS;
- Address flood risk through improved engagements with wider partners and key communities, increasing public awareness on the effects of climate change and how to manage/mitigate the risks;
- Maximise investment opportunities to build, maintain and improve local flood and coastal infrastructure and systems to mitigate and reduce damage from flooding;
- Work with climate change action groups to ensure actions to address flood risk and coastal erosion are incorporated within climate change action plans;
- Improve the detection, forecasting and issue of warnings of flooding, and planning and co-ordinating a rapid response to flood emergencies to promote faster recovery from flooding; and
- Consider the feasibility of delivering a number of 'water resilient parks' across Lancashire to retrofit SuDS and natural flood management measures to contribute towards surface water storage.

The Lune and Wyre CFMPs give an overview of the flood risk in the respective catchments and set out plans for sustainable flood risk management.

Assessment of cross-boundary issues

The neighbouring local authority in which catchments located within the LCiC administrative area drain into, shown in Figure 6-3, is Wyre District Council.

Figure 6-4 shows the catchments in Lancaster mapped against the topography and the direction they drain. As Lancaster lies on the coast, the majority of the western catchments drain to the sea, while the northern and eastern catchments drain into the Lancaster authority area. There are three catchments in the south-west which drain out of the LCiC administrative area. This means that development within this section of Lancaster is more likely to have the potential to increase flood risk to neighbouring authorities south of the district, where development in the northern and eastern neighbouring local authorities is more likely to impact Lancaster.

The neighbouring authorities that contain catchments which drain into the LCiC authority area are Craven District, Ribble Valley and South Lakeland.

Growth in neighbouring authorities was considered in the cumulative impact assessment outlined below. There were 15 development sites found within Craven District that are located within the Greta and Wenning – Lower catchments that drain into the east of the district. Additionally, 20 development sites were identified within the South Lakeland District within the Keer Upper catchments that drain into the north of Lancaster. In the remaining neighbouring authorities, there are no significant development sites on catchments draining into Lancaster District. In the vast majority of cases, if appropriate drainage and SuDS are adopted, development in the neighbouring authorities is unlikely to significantly affect flood risk.

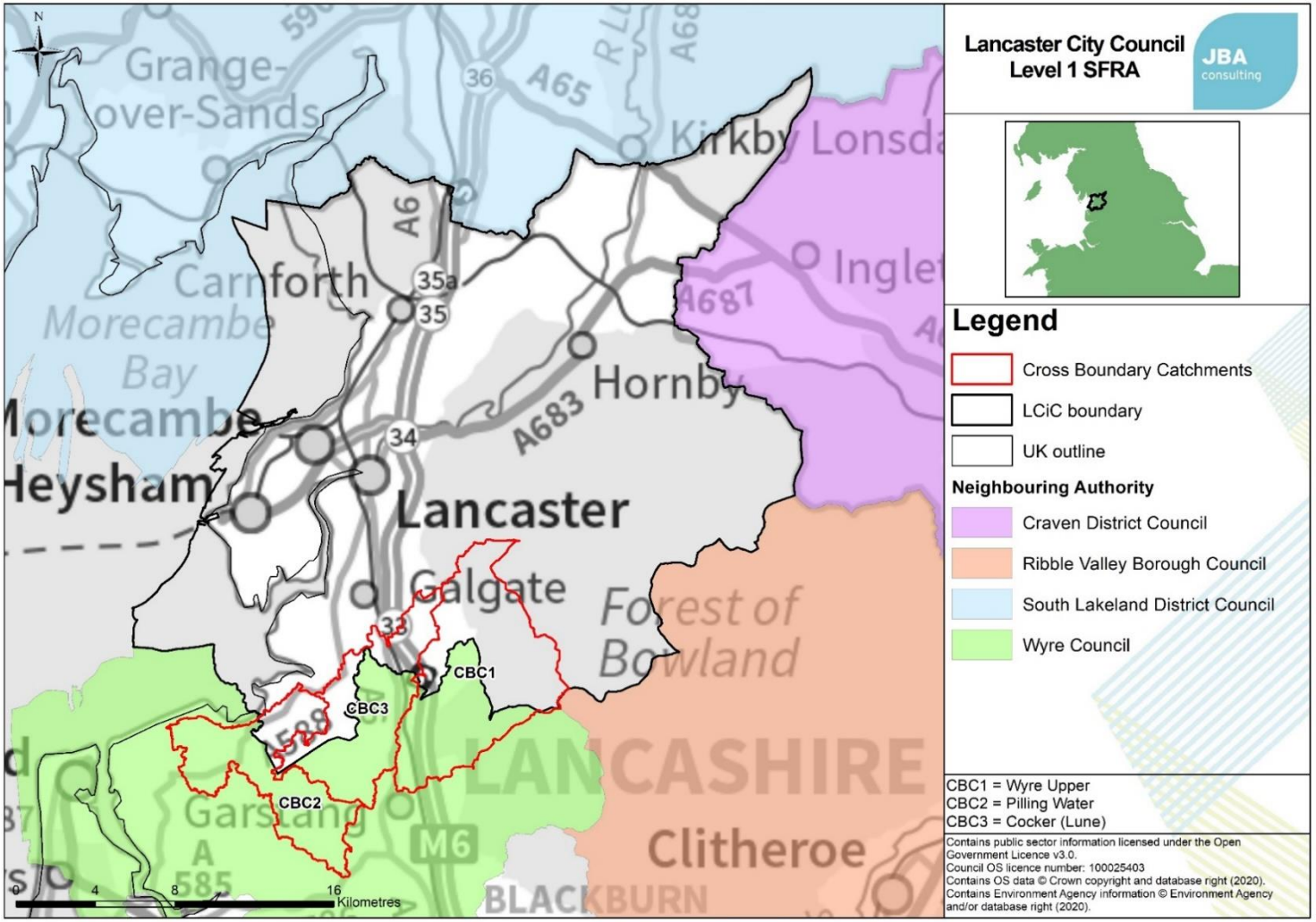

Figure 6-3: Cross boundary catchments draining out of the LCiC area into neighbouring local authorities

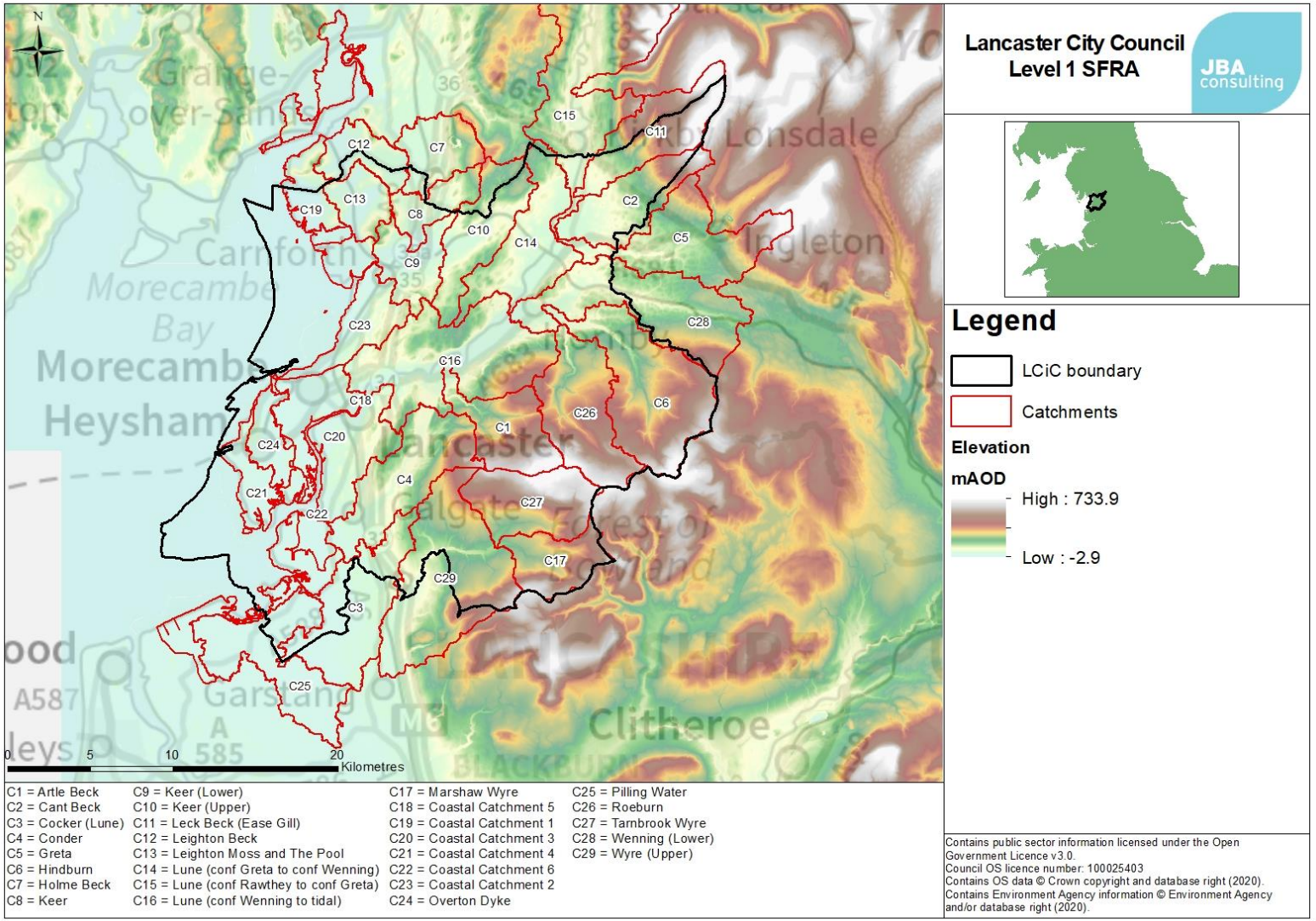

Figure 6-4: River catchments and topography in Lancaster

Consequently, there are a number of catchments that exist within the district where future development may impact flood risk in the neighbouring Local Authority outlined above, particularly where there are existing flood risk issues. Table 6-1 summarises which catchments drain out of Lancaster, and any downstream existing flood risk issues that have the potential to be exacerbated. The sources of data used to inform the existing flood risk issue to properties in neighbouring local authorities can be found in Appendix I.

The Local Plan for South Lakeland District Council is being updated alongside the evidence base (i.e. SFRAs, Sustainability Appraisals etc.) and therefore, their flood risk and drainage policies are not yet formalised. However, it is very likely that to ensure compliance with the NPPF, appropriate sustainable drainage and flood risk policies will be proposed. There are summaries below of the relevant drainage and flood risk policies relating to the Local Plans for Craven District Council, Ribble Valley Borough Council and Wyre Council.

Craven District Council's Local Plan 2012-2032

Craven District Council's Local Plan was adopted 12 November 2019, and the following policies are relevant to the district's flood risk and drainage strategy:

- PO8: Address and mitigate flood risk as a response to climate change and as a barrier to local economic growth
- ENV3: Good design
- ENV5: Green infrastructure
- ENV6: Flood risk
- ENV8: Water resources, water quality and groundwater

Ribble Valley Borough Council's Core Strategy 2008-2028

A districtwide Local Plan was adopted by the Council in 1998 and its remaining saved policies are now superseded by the Core Strategy 2008-2028: A Local Plan for Ribble Valley, which was formally adopted on 16 December 2014. The following policies are relevant to the borough's flood risk and drainage strategy:

- EN3: Sustainable development and climate change
- DME6: Water management

Wyre Council's Adopted Local Plan 2011-2031

Wyre Council's Local Plan was adopted 28 February 2019, and the following policies are relevant to the district's flood risk and drainage strategy:

- SP2 Sustainable development
- SP7 Infrastructure provision and developer contributions
- CDMP2 Flood Risk and Surface Water Management
- CDMP4 Environmental Assets

It is recommended that Lancaster City Council consults with neighbouring authorities when developing flood risk and drainage planning policies to ensure they are complementary. The outputs of this assessment may have implications for planning policy in high risk catchments outside of the Lancaster City Council boundary.

Catchment	Neighbouring Local Authority downstream	Details	Existing Flood Risk Issues
Pilling Water catchment	Wyre Council	An unnamed drain to the south of Lancaster City Council drains into Wyre Council.	A small portion of this catchment exists within Lancaster City Council, and the majority of the floodplain occupies land in adjacent Wyre Council. Development in Lancaster City Council is not likely to significantly impact flood risk to properties in this catchment.
Cocker (Lune) catchment	Wyre Council	The River Cocker and Lancaster Canal drain into Wyre Council.	The majority of the floodplain of the Cocker (Lune) catchment occupies rural land within Wyre Council. Development within this catchment in Lancaster City Council is not likely to significantly impact flood risk to properties in this catchment.
Wyre – Upper catchment	Wyre Council	The River Wyre drains into Wyre Council.	There has been one instance of property flooding within the Wyre Upper catchment during a rainfall event in 2015. A number of properties in this catchment in Wyre District are located within Flood Zone 3 and are at risk of flooding from surface water. Development within this catchment in Lancaster City Council has the potential to impact flood risk to the existing properties in Wyre Council.

Table 6-1: Summary of catchments that drain into neighbouring Local Authorities from Lancaster district

Policy recommendations with regards to managing the cumulative impacts of development have been made in the section below. This will help to ensure there is no incremental increase in flood risk both within and downstream of Lancaster City Council. The catchments and topography within Lancaster are shown in Figure 6-4. The direction of catchment drainage in or out of Lancaster district for catchments that straddle neighbouring Local Authority boundaries is shown in Figure 6-5.

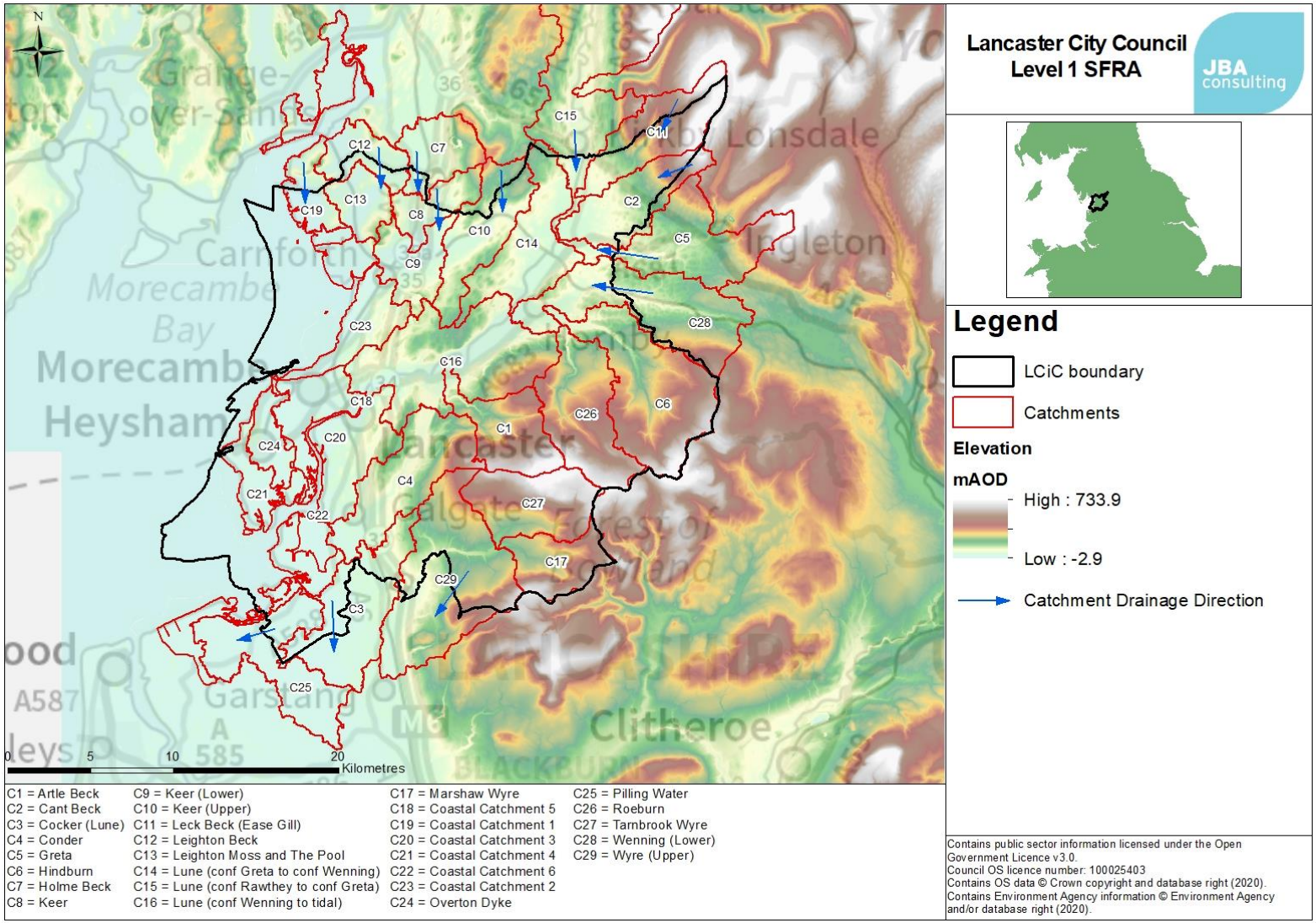

Figure 6-5: River catchments and the direction of drainage in or out of Lancaster

Cumulative Impact Assessment

A cumulative impact assessment was undertaken for this SFRA. To assess which catchments are at the highest risk of flooding and where the cumulative impact of development may have the biggest effect, historic flood risk and areas that are most sensitive to increases in flood risk were assessed.

The methodology for the Cumulative Impact Assessment is in Appendix I. The policy recommendations can be found in the section below.

The results of the cumulative assessment can be summarised to give a rating of low, medium or high risk for each catchment. The rating of each catchment in each of these assessments was combined to give an overall ranking. The highest overall ranked catchments are shown in Table 6-2 and a map of the catchment ratings shown in Figure 6-6.

Catchment	Number of historic flood events	Sensitivity to increases in flood flows*	% area of development sites within catchment**	Potential to impact neighbouring local authority	Potential for neighbouring local authority to impact flood risk	Total Score (max score of 9)	Final rating***
Overton Dyke	50	370%	1.9%	No	No	6	High
Coastal Catchment 1	1	300%	0%	No	Yes	6	High
Coastal catchment 2	43	421%	0.6%	No	No	6	High
Coastal Catchment 3	138	357%	6.3%	No	No	8	High
Coastal catchment 4	13	600%	1.8%	No	No	7	High
Lune (conf Wenning to tidal)	47	153%	2.4%	No	No	6	High
Wenning Lower	13	92%	0.02%	No	Yes	7	High

Table 6-2: The results for the highest risk catchments after cumulative impact analysis

* This is the measure of the increase in the number of properties at risk of surface water flooding in a 1 in 100-year event to a 1 in 1000-year event. It is an indicator of where local topography makes an area more sensitive to increases in flood risk that may be due to any number of reasons, including climate change, new development etc. It is not an absolute figure or prediction of the impact that new development will have on flood risk.

** This is the measure of the area of development sites within each catchment taken as a percentage of the total area in each catchment.

*** The final rating divides the Total Scores up into different bands to assign a rating of high, medium or low. A score of >6 = High, 4-5 = Medium and 0-3 = Low.

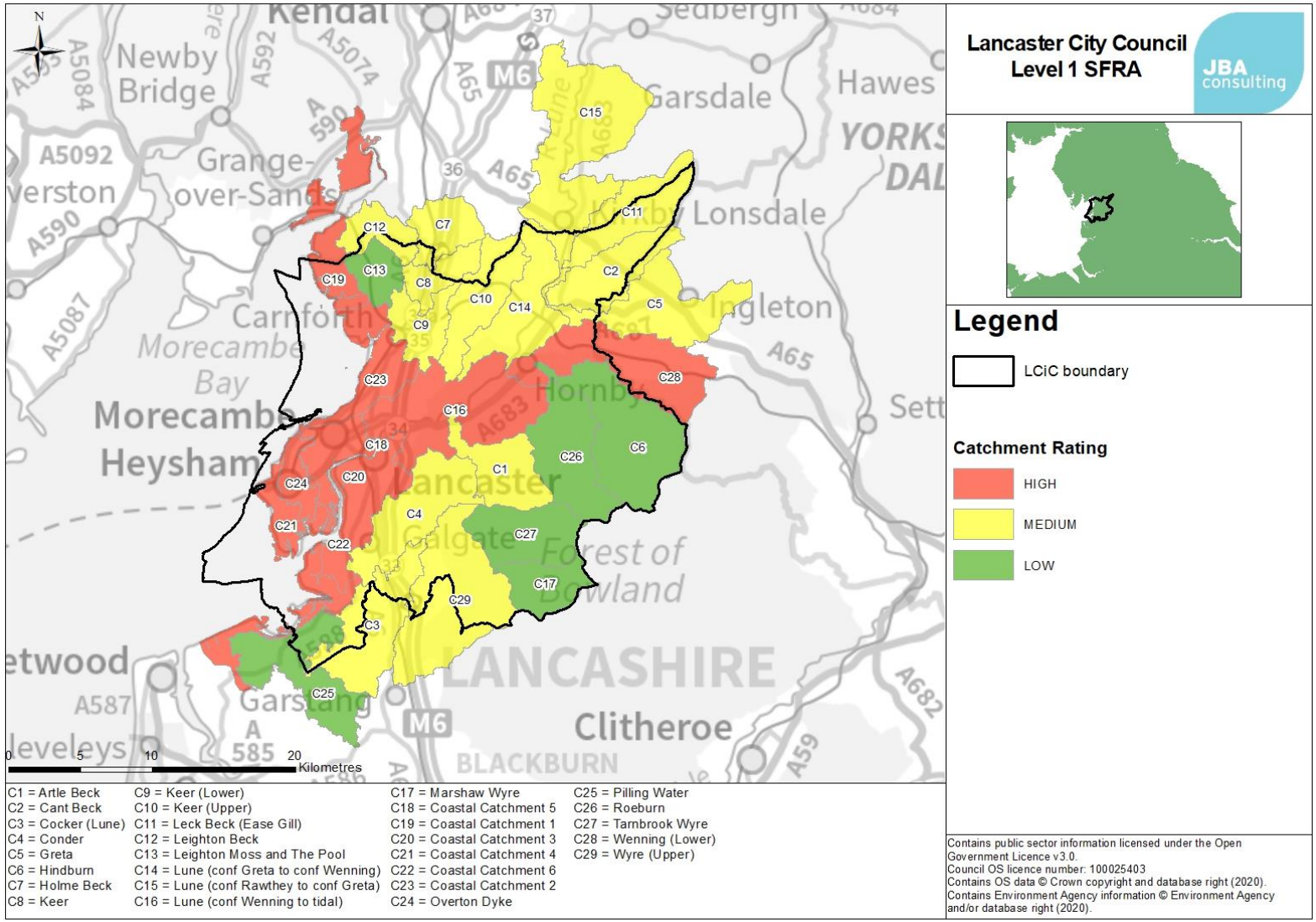

Figure 6-6: Map of the results of the cumulative impact assessment for each of the catchments

The Cumulative Impact Assessment supports a tiered approach, with bespoke policy depending on the location of the development. Specific policy recommendations relate to:

- High risk urban catchments (Policy Recommendation 1)
- High risk rural catchments (Policy Recommendation 2)

The remaining medium and low risk catchments in the borough are assigned a different policy recommendation:

- All catchments council wide including ones at lower risk (Policy Recommendation 3)

Policies 1 and 2 relate to the high risk 'red' catchments seen in Figure 6-6, whereas Policy 3 relates to all other 'yellow' and 'green' catchments within Lancaster City Council administrative area. More details regarding the Policies can be found in the section below.

Recommendations from the Cumulative Impact Assessment

Policy Recommendation 1: High risk urban catchments

Mapping of these catchments can be found in Figure 6-3. High-risk catchments are detailed within Table 6-2.

- Coastal catchment 2 (C23)
- Coastal catchment 3 (C20)
- Coastal catchment 4 (C21)
- Overton Dyke (C24)
- Lune – conf Wenning to tidal (C16)
- Wenning – Lower (C28)

Lancaster City Centre falls within Coastal catchment 3, which received a high-risk rating in the cumulative impact analysis. In addition to this, Heysham falls within both the Overton Dyke catchment and Coastal catchment 4. Morecambe lies within Coastal catchment 2.

All new development (other than minor extensions) in these catchments should:

- Consider site specific Flood Risk Assessments to demonstrate what measures can be put in place to contribute to flood risk reduction downstream. This could be through SuDS, natural flood management techniques, green infrastructure, and green-blue corridors.
- Look to maintain existing key blue and green spaces including those identified in the Green and Blue Infrastructure Strategy, particularly where there is an environmental or climate change mitigation value, and consider creating additional blue and green infrastructure, combing these with the existing network, unless other development pressures outweigh the need for maintaining existing blue/green areas. Key green spaces within high risk urban catchments should be identified to protect from future development. The allocation of such spaces is however outside the scope of the Climate Emergency Local Plan Review.
- Produce a Green and Blue Infrastructure Management and Maintenance Plan to set out the effective management of green and blue infrastructure assets so they can continue to deliver the long-term benefits they were designed to provide.
- Surface Water Drainage Strategies consistent with local planning requirements will be required for all developments in this catchment, regardless of development size.

Policy Recommendation 2: High risk large rural catchments with localised flood risk issues

Mapping of these catchments can be found in Figure 6-3. High-risk catchments are detailed within Table 6-2.

- Coastal catchment 1 (C19)

Opportunities within rural catchments should be explored to:

- Promote environmental land management practices to attenuate surface water runoff, through methods such as cover crops, riparian borders, and infiltration techniques, to alleviate potential issues downstream.
- Promote community resilience in rural areas where immediate assistance following serious flood events might not be possible.
- The LPA should work closely with the Environment Agency and Lancaster County Council as LLFA to identify areas of land that should be safeguarded for the future use of natural flood management features

Policy Recommendation 3: Applicable across the borough to minimise Cumulative Impact

This policy applies to all catchments that received a medium-risk or low-risk catchment rating in the Cumulative Impact Assessment

All new development in these catchments should:

- Incorporate green and blue infrastructure into development plans, through both maintaining current green and blue spaces and also creating additional infrastructure to promote recreation, water management, biodiversity and climate change mitigation. Proposals involving the loss of designated green or blue spaces will be resisted by Lancaster City Council unless appropriate mitigations measures have been considered. See Section 5.7.6.
- Integrate Surface Water Drainage Strategies in accordance with local requirements for all major and non-major developments. These should take into account all sources of flooding to ensure that future development is resilient to flood risk and does not increase flood risk elsewhere

6.4.3 Safeguarding land for flood storage

In some instances, the storage of flood water can help to alleviate flooding elsewhere, such as downstream developments. Where there is a large area of a site at risk that is considered large enough to hinder development, it may be appropriate to safeguard this land for the storage of flood water.

Applicable sites assessed through this SFRA may include any current greenfield sites:

- That are considered to be large enough (i.e. >1 hectare) and close enough to the floodplain to store floodwater to achieve effective mitigation,
- With large areas of their footprint at high or medium surface water flood risk (based on the RoFSW),
- That are within the functional floodplain (Flood Zone 3b),
- With large areas of their footprint at risk from Flood Zone 3a, and
- That are large enough and within a suitable distance to receive floodwater from a nearby development site using appropriate SuDS techniques which may involve pumping, piping or swales / drains.

Brownfield sites could also be considered though this would entail site clearance of existing buildings and hardstanding areas, conversion to greenspace and contaminated land assessments.

By using the sequential approach to site layout, the LPA and developers should be able to avoid the areas at risk and leave clear for potential flood storage. See the SFRA Maps in Appendix A to spatially assess the areas of the sites at risk.

6.4.4 Phasing of development

Flood risk should be taken into account at all stages of the planning process with a view to directing development away from areas at flood risk, now and in the future, by following the sequential approach to site allocation.

Using a phased approach to development, based on modelling results of floodwater storage options through a FRA, should ensure that any sites at risk of causing flooding to other sites are developed first in order to ensure flood storage measures are in place before other sites are developed, thus ensuring a sustainable approach to site development. Also, it may be possible that flood mitigation measures put in place at sites upstream could alleviate flooding at downstream or nearby sites. Large strategic multiple development sites should also carry out development phasing within the overall site boundary so as to avoid cumulative impacts within the site, as well as off the site (see Section 5.7.6 for information on Natural Flood Management).

6.5 Guidance for developers

This SFRA provides the evidence base for developers to assess flood risk at a strategic level and to determine the requirements of an appropriate site-specific FRA. Before carrying out an FRA, developers should check with the LPA whether the Sequential Test has been carried out. If not, the developer must apply the Sequential Test as part of their FRA by comparing their indicative development site with other available sites to ascertain which site has the lowest flood risk. The EA provides advice on this process via:

https://www.gov.uk/guidance/flood-risk-assessment-the-sequential-test-for-applicants

LCiC's Local Plan policies on Water Management should also be consulted and adhered to. See Appendix D of this SFRA.

An Exception Test will be required for allocated sites where the flood risk has changed since the 2017 SFRA and subsequent allocation.

Table 6-3 identifies, for developers, when the Sequential and Exception Tests are required for certain types of development and who is responsible for providing the evidence and those who should apply the test if required.

Development	Sequential Test Required?	Who Applies the Sequential Test?	Exception Test Required?	Who Applies the Exception Test?
Allocated Sites	No (assuming the development type is the same as that submitted via the allocations process)	LPA should have already carried out the test during the allocation of development sites	Dependent on land use vulnerability and whether the flood risk has changed since the 2017 SFRA and allocation	LPA to advise on the likelihood of test being passed. The developer must also provide evidence that the test can be passed by providing planning justification and producing a detailed FRA
Windfall Sites	Yes	Developer provides evidence, to the LPA that the test can be passed. An	Dependent on land use vulnerability	Developer must provide evidence that the test can be passed by providing

Development	Sequential Test Required?	Who Applies the Sequential Test?	Exception Test Required?	Who Applies the Exception Test?
		area of search will be defined by local circumstances relating to the catchment and for the type of development being proposed		planning justification and producing a detailed FRA
Regeneration Sites Identified Within Local Plan	No	-	Dependent on land use vulnerability and whether the flood risk has changed since the 2017 SFRA and allocation	LPA to advise on the likelihood of test being passed. The developer must also provide evidence that the test can be passed by providing planning justification and producing a detailed FRA
Redevelopment of Existing Single Properties	No	-	Dependent on land use vulnerability	Developer must provide evidence that the test can be passed by providing planning justification and producing a detailed FRA
Changes of Use	No (except for any proposal involving changes of use to land involving a caravan, camping or chalet site)	Developer provides evidence to the LPA that the test can be passed	Dependent on land use vulnerability	Developer must provide evidence that the test can be passed by providing planning justification and producing a detailed FRA

Table 6-3: Development types and application of Sequential and Exception Tests for developers

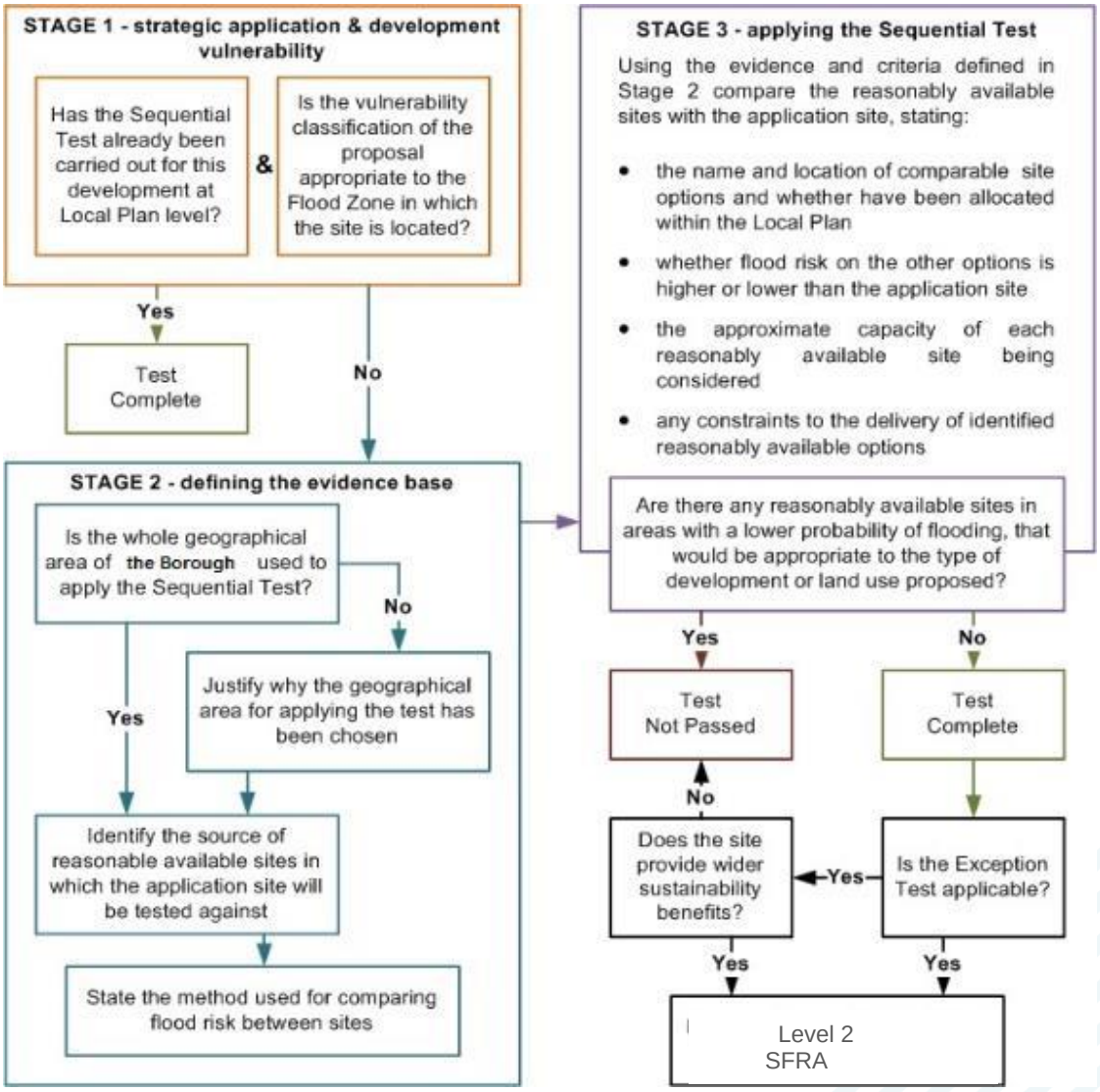

Figure 6-7: Development management Sequential Test process

Figure 6-7 shows what developers should do with regards to applying the Sequential Test if the LPA has not already done so.

The Sequential Test does not apply to change of use applications unless it is for change of land use to a caravan, camping or chalet site, or to a mobile home site or park home site. The Sequential Test can also be considered adequately demonstrated if both of the following criteria are met:

- The Sequential Test has already been carried out for the site (for the same development type) at the strategic level (Local Plan); and
- The development vulnerability is appropriate to the Flood Zone (see Table 3 of the FRCC-PPG).
    - **If both these criteria are met,** reference should be provided for the site allocation of the Local Plan document and the vulnerability of the development should be clearly stated.
    - When applying the Sequential Test, the following should also be considered:
- The geographic area in which the Test is to be applied;

- The source of reasonable available sites in which the application site will be tested against; and
- The evidence and method used to compare flood risk between sites.

Sites could be compared in relation to flood risk, Local Plan status; capacity; and constraints to delivery including availability, policy restrictions, physical problems or limitations, potential impacts of the development on the local area, and future environmental conditions that would be experienced by the inhabitants of the development.

The test should conclude if 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 that has been put forward in the Local Plan.

The LPA should now have sufficient information to be able to assess whether or not the indicative site has passed the Sequential Test. If the Test has been passed, then the developer should apply the Exception Test in the circumstances set out by tables 1 and 3 of the FRCC-PPG.

In all circumstances, where the site is within areas at risk of flooding, a site-specific FRA should be completed in line with the NPPF and the FRCC-PPG.

In addition to the formal Sequential Test, the NPPF sets out the requirement for developers to apply the sequential approach to locating development within the site. As part of their application and masterplanning discussions with applicants, LPAs should seek whether or not:

- Flood risk can be avoided by substituting less vulnerable uses or by amending the site layout;
- Less vulnerable uses for the site have been considered; or
- Density can be varied to reduce the number or vulnerability of units located in higher risk parts of the site.

When initially considering the development options for a site, developers should use this SFRA, the NPPF and the FRCC-PPG to:

- ***Identify whether the site***
    - *Is a windfall development, allocated development, within a regeneration area, single property, or subject to a change of use to identify if the Sequential and Exception Tests are required;*
    - *If flood risk has changed since the 2017 SFRA and site allocation to require Exception Tests*
- ***Check whether the Sequential Test and / or the Exception Test have already been applied***
    - *Request information from the LPA on whether the Sequential Test, or the likelihood of the site passing the Exception Test, have been assessed;*
    - *If not, provide evidence to the LPA that the site passes the Sequential Test and will pass the Exception Test.*
- ***Consult with the LPA, the LLFA and the EA and the wider group of flood risk consultees, where appropriate, to scope an appropriate FRA if required***
    - *Guidance on FRAs is provided in Section 6.6.1 of this SFRA;*
    - *Depending on the risk, the developer may also refer to the EA Standing Advice, Ciria Report C624 for flood risk and development, LCoC SuDS Design Guidance and the NPPF and the FRCC-PPG;*
    - *Consult the LLFA*
- ***Submit FRA to the LPA and the EA for approval, as required***

6.5.1 Site-specific Flood Risk Assessment

A site-specific FRA is required for the majority of site planning applications. The FRA should assess whether a potential development is likely to be affected by current or future flooding (including effects of climate change) from any source. This should include referencing this SFRA to establish sources of flooding. Further analysis should be performed to improve the understanding of flood risk including agreement with the LPA and the EA on areas of functional floodplain that have not been specified within this SFRA. The LLFA should be consulted on risk from surface water and from ordinary watercourses.

According to the FRCC-PPG (Para 030), a site-specific FRA is:

"…carried out by (or on behalf of) a developer to assess the flood risk to and from a development site. Where necessary (see footnote 50 in the National Planning Policy

Framework), the assessment should accompany a planning application submitted to the local planning authority. The assessment should demonstrate to the decision-maker how flood risk will be managed now and over the development's lifetime, taking climate change into account, and with regard to the vulnerability of its users (see Table 2 – Flood Risk Vulnerability of FRCC-PPG)."

The objectives of a site-specific FRA are to establish:

- The risk of flooding to the site;
- Whether the development will increase flood risk elsewhere;
- Whether the measures proposed to deal with these effects and risks are appropriate;
- The evidence for the local planning authority to apply (if necessary) the Sequential Test;
- Whether the development will be safe for its lifetime and can pass the Exception Test, if applicable; and
- That an appropriate Emergency Plan is in place that accounts for the possibility of a flood event and shows the availability of safe access and egress points accessible during times of flood. (Para 030)

When is a Site-Specific FRA Required?

According to the NPPF (2021) footnote 55, a site-specific FRA should be prepared when the application site is:

- Situated in Flood Zone 2 and 3; for all proposals for new development (including minor development and change of use);
- 1 hectare or greater in size and located in Flood Zone 1;
- Located in Flood Zone 1 on land which has been identified by the EA as having critical drainage problems (i.e. within an ACDP);
- Land identified in the SFRA as being at increased flood risk in future (see climate change modelling outputs);
- At risk of flooding from other sources of flooding, such as those identified in this SFRA; or
- Subject to a change of use to a higher vulnerability classification which may be subject to other sources of flooding.

Optionally, the LPA may also like to consider further options for stipulating FRA requirements, such as:

- Situated in an area currently benefitting from defences;
- At residual risk from reservoirs or canals; or
- Situated over a culverted watercourse or where development will require controlling the flow of any watercourse, drain or ditch or the development could potentially change structures known to influence flood flow.

These further options should be considered during the preparation and development of the Local Plan.

Paragraph 031 of the FRCC-PPG contains information regarding the level of detail required in the FRAs and indicates that it should always be proportionate to the degree

of flood risk whilst making use of existing information, including this SFRA. Paragraph 068 of the FRCC-PPG contains an easy-to-follow FRA checklist for developers to follow.

Together with the information in the FRCC-PPG, there is further detail and support provided for the LPA and developers via:

https://www.gov.uk/guidance/flood-risk-assessment-standing-advice

advice for LPAs:

https://www.gov.uk/guidance/flood-risk-assessment-local-planning-authorities

also, EA guidance for Flood Risk Assessments for planning applications:

https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications

6.6 Planning for climate change

In relation to flood risk and climate change in the planning system, the NPPF states:

"All plans should apply a sequential, risk-based approach to the location of development – taking into account the current and future impacts of climate change – so as to avoid, where possible, flood risk to people and property." (para 161).

Local plans should do this by safeguarding land from development that is required, or likely to be required, for current or future flood management; and to seek opportunities for the relocation of development, including housing, to more sustainable locations from areas where climate change is expected to increase flood risk.

6.6.1 EA climate change allowances

The EA revised the climate change allowances in 2021, for use in FRAs and SFRAs and will use these revised allowances when providing advice. There have been several updates carried out to the allowances since the release of UKCP18. The most up-to-date allowances are available online via:

https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Developers should refer to the climate change allowances on the Government website to ensure those outlined below are the most up-to-date available.

The climate change allowances are predictions of anticipated change for:

- Peak river flow by Management Catchment (see Table 6-4 for Lune and Wyre allowances);
- Peak rainfall intensity;
- Sea level rise; and
- Offshore wind speed and extreme wave height.

Management catchment	Allowance Category	Total Potential Change Anticipated for…		
		2020s (2015-2039)	2050s (2040-2069)	2080s (2070-2125)
Lune	Upper end	+33%	+58%	+92%
	Higher central	+24%	+38%	+61%
	Central	+20%	+30%	+49%
Wyre	Upper end	+29%	+44%	+67%
	Higher central	+22%	+29%	+44%
	Central	+18%	+23%	+35%

Table 6-4: Recommended peak river flow allowances for the Lune and Wyre management catchments

At the time of preparing the climate change modelling for the SFRA, the new peak river flow allowances and peak rainfall intensities were not yet released and indicative allowances were agreed with the EA shown below in Table 6-5. The indicative allowances that were agreed were greater than the 2016 values and more representative at the catchment scale as opposed to the larger North West river basin district scale used for the 2016 allowances.

Allowance category	Total anticipated change for the 2080s (2070-2115)
Upper end	+75%
Higher central	+60%
Central	+45%

Table 6-5: Indicative peak river flow allowances for the Lune management catchment

To gauge the impacts of climate change on surface water, the EA states the allowances for peak rainfall intensities provided in Table 6-6 should be used. The peak rainfall intensity allowances apply to the whole of England for small catchments (less than 5 km^2) and urban catchments. SFRAs and FRAs should assess both the central and upper end allowances to gauge the range of impacts. Note: surface water climate change modelling has not been carried out for this SFRA, however, Appendix F details the results of an assessment of surface water attenuation requirements for each Local Plan allocation.

Allowance category	Total potential change anticipated for…		
	2015-2039	2040-2069	2070-2115
Upper end	+10%	+20%	+40%
Central	+5%	+10%	+20%

Table 6-6: Peak rainfall intensity allowances in small and urban catchments for England

Allowances for sea level rise are based on river basin district and were last updated in 2019. The allowances for the North West RBD are shown in Table 6-7. The number in brackets is the cumulative sea level rise for each year within each range. The EA

expects SFRAs and FRAs to assess both allowance categories and also the H++ allowance in some cases. The H++ scenario for sea level rise for England is set at a total sea level rise of 1.9 metres, up to the year 2100.

Allowance category	2096 to 2125 (mm)	Cumulative rise 2000 to 2125 (metres)
Higher central	11.2 (336)	1.01
Upper end	16.3 (489)	1.41

Table 6-7: Sea level allowance for the North West RBD.

6.6.2 Climate change modelling

A list of 12 EA hydraulic models were updated to produce updated modelled results and climate change outlines to support the SFRA. For peak river flows, the uplift values listed in Table 6-5 were used for each fluvial model and for tidal models the values in Table 6-7 were used. Table 6-8 below lists the models that were updated and which watercourses and return periods were modelled. The modelled climate change outlines are presented on the SFRA maps in Appendix A.

Watercourse	Model name	Fluvial/tidal?	Return periods modelled
Drain at Back Lane	Back Lane (2017) – FM-TUFLOW	Fluvial	Q20 Q100
Burrow Beck	Burrow Beck (2019) – FM-TUFLOW	Fluvial	Q20 Q100 Q1000
River Wyre	Dolphinholme (2018) – FM-TUFLOW	Fluvial	Q20 Q100 Q1000
River Roeburn / River Hindburn	Wray (2018) – FM-TUFLOW	Fluvial	Q20 Q100
River Lune	Caton (2019) – FM-TUFLOW	Fluvial	Q20 Q100
River Conder	Conder (2020) – FM-TUFLOW	Fluvial	Q20 Q100 Q1000
River Wenning	Wenning (2020) – HEC-RAS	Fluvial	Q20 Q100
Drain at Back Lane	Back Lane (2020) - HEC-RAS	Fluvial	Q20 Q100 Q1000
River Keer	Keer (2020) – HEC-RAS	Fluvial	Q20 Q100 Q1000
River Conder	Glasson – ESTRY-TUFLOW	Fluvial	Q100 Q1000
River Lune	Lune - TUFLOW	Tidal	T200 T1000
River Keer	Keer - TUFLOW	Tidal	T200 T1000

Table 6-8: EA models updated for climate change allowances

6.7 Sustainable Drainage Systems (SuDS)

Development has the potential to cause an increase in impermeable area, an associated increase in surface water runoff rates and volumes, and consequently a potential increase in downstream flood risk due to overloading of sewers, watercourses, culverts and other drainage infrastructure. Managing surface water discharges from new development is therefore crucial in managing and reducing flood risk to new and existing development downstream. Carefully planned development can also play a role in reducing the amount of properties that are directly at risk from surface water flooding. Brownfield development should seek to reduce flood risk by reducing run-off to greenfield rates or where this is not possible at least 30%.

The Department for Communities and Local Government (DCLG) (now Ministry of Housing, Communities & Local Government (MHCLG)) announced, in December 2014, that the local planning authority, in consultation with the LLFA, should be responsible for delivering SuDS[14] through the planning system. Changes to planning legislation gave provisions for major applications of ten or more residential units or equivalent commercial development to require sustainable drainage within the development proposals in accordance with the 'non-statutory technical standards for sustainable drainage systems'[15], published in March 2015. A Practice Guidance[16] document has also been developed by the Local Authority SuDS Officer Organisation (LASOO), now the Association of SuDS Authorities (ASA), to assist in the application of the non-statutory technical standards.

In order to manage flood risk, all development, regardless of development type, flood zone and development size, must give priority use to SuDS. Particularly for major developments, there is a requirement to assess and include SuDS for managing surface water at the development unless it is demonstrated during the assessment that it is inappropriate for the site.

In order to satisfy the NPPF and its accompanying PPG, applicants must demonstrate that priority has been given to the use of SuDS in their development proposals. SuDS should be provided by default unless demonstrated to be inappropriate. Where priority use of SuDS cannot be achieved, applicants must justify this by submitting robust and acceptable evidence.

The NPPF, para 169, states:

"Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:

a. take account of advice from the lead local flood authority;

b. have appropriate proposed minimum operational standards;

c. ***have maintenance arrangements, in place to ensure an acceptable standard of operation for the lifetime of the development;*** *and*

d. where possible, provide multifunctional benefits".

Although the NPPF states only 'major' developments should incorporate SuDS, all development proposals, for both major and minor development, should include SuDS, providing multiple benefits that contribute to many other NPPF policies, including climate change. Where site conditions may be more challenging, the types of SuDS may need to be adapted. At a strategic level, this should mean identifying SuDS

14 http://www.parliament.uk/business/publications/written-questions-answers-statements/written-statement/Commons/2014-12-18/HCWS161/

15 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf

16 http://www.susdrain.org/files/resources/other-guidance/lasoo_non_statutory_suds_technical_standards_guidance_2016_.pdf

opportunities and constraints according to geology, soil type, topography, groundwater / mine water conditions and potential impacts on site allocation and yields. Local SuDS guidance should then be developed including instructions on adoption and maintenance.

Maintenance options must clearly identify who will be responsible for SuDS maintenance and funding for maintenance should be fair for householders and premises occupiers, and, set out a minimum standard to which the SuDS must be maintained.

Sustainable drainage should form part of an integrated design methodology secured by detailed planning conditions to ensure that the SuDS to be constructed is maintained to a minimum level of effectiveness.

The Local Standards for Lancashire County Council as LLFA are the North West SuDS Pro-Forma Guidance published in July 2020[17].

6.7.1 SuDS hierarchy

The runoff destination should always be the first consideration when considering design criteria for SuDS including the following possible destinations in order of preference:

1. To ground;
2. To surface waterbody;
3. To surface water sewer;
4. To combined sewer.

Effects on water quality should also be investigated when considering runoff destination in terms of the potential hazards arising from development and the sensitivity of the runoff destination. Developers should also establish that proposed outfalls are hydraulically capable of accepting the runoff from SuDS through consultation with the LLFA and UU as appropriate. The EA will consider the potential impact of the outfall structure on fluvial flood risk through the planning consultation and Environmental Permitting Regulation process, however. Detailed modelling won't be available for all outfalls, so developers should carry out their own investigations.

The non-statutory technical standards for sustainable drainage systems (March 2015) sets out appropriate design criteria based on the following:

1. Flood risk outside the development;
2. Peak flow control;
3. Volume control;
4. Flood risk within the development;
5. Structural integrity;
6. Designing for maintenance considerations;
7. Construction.

Many different SuDS techniques can be implemented. As a result, there is no one standard correct drainage solution for a site. In most cases, using the Management Train principle (see Figure 6-8), will be required, where source control is the primary aim.

[17] https://www.lancashire.gov.uk/media/919089/nw-suds-pro-forma-guidance.pdf

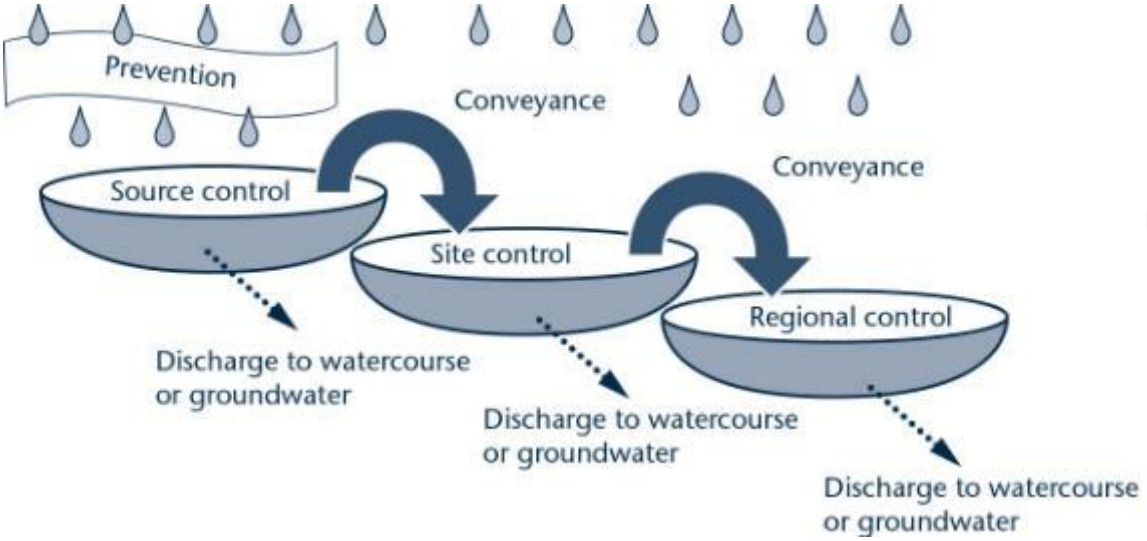

Figure 6-8: SuDS management train principle

The effectiveness of a flow management scheme within a single site is heavily limited by land use and site characteristics including (but not limited to) topography, geology and soil (permeability), and available area. Potential ground contamination associated with urban and former industrial sites should be investigated with concern being placed on the depth of the local water table and potential contamination risks that will affect water quality. The design, construction and ongoing maintenance regime of any SuDS scheme must be carefully defined as part of a site-specific FRA. A clear and comprehensive understanding of the catchment hydrological processes (i.e. nature and capacity of the existing drainage system) is essential for successful SuDS implementation.

In addition to the national standards, the LPA or LLFA may set local requirements for planning permission that include more rigorous obligations than the non-statutory technical standards. More stringent requirements should be considered where current Greenfield sites lie upstream of high-risk or densely populated areas. This could include improvements on Greenfield runoff rates. The LPA and LLFA should always be contacted with regards to any local requirements at the earliest opportunity in development planning.

Developers should refer to LCiC's Local Plan policies on Water Management, outlined in Appendix D. The CIRIA SuDS Manual[18] 2015 should also be consulted by the LPA and developers. The SuDS manual (C753) is highly regarded and incorporates the latest research, industry practice, technical advice and adaptable processes to assist in the planning, design, construction, management and maintenance of good SuDS. The SuDS Manual complements the non-statutory technical standards and goes further to support the cost-effective delivery of multiple benefits.

6.8 Drainage for new developments

Development has the potential to cause an increase in impermeable area, an associated increase in surface water runoff rates and volumes, and a consequent potential increase in downstream flood risk due to overloading of sewers, watercourses, culverts and other drainage infrastructure.

Managing surface water discharges from new development is crucial in managing and reducing flood risk to new and existing development.

18 https://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx

Carefully planned development can also play a role in reducing the amount of properties that are directly at risk from surface water flooding. The Planning System has a key role to play in setting standards for sustainable drainage from new developments and ensuring that developments are designed to take account of the risk from surface water flooding. Sustainable drainage plays an important part in reducing flows in the sewer network and in meeting environmental targets, alongside investment in maintenance by the water companies on their assets. Water companies plan their investment on a five-year rolling cycle, in consultation with key partners, including the EA and local authorities.

Again, developers should refer to LCiC's Local Plan policies on Water Management, outlined in Appendix D.

6.8.1 Overland flow paths

Underground drainage systems have a finite capacity and regard should always be given to larger events when the capacity of the network will be exceeded. Hence there is a need to design new developments with exceedance in mind. This should be considered alongside any surface water flows likely to enter a development site from the surrounding area.

Masterplanning should ensure that existing overland flow paths are retained within the development. As a minimum, the developer should investigate, as part of a site-specific FRA, the likely extents, depths and associated hazards of surface water flooding on a development site, as indicated at the strategic level by the RoFSW dataset. This is considered to be an appropriate approach to reduce the risks of flooding to new developments. Green infrastructure should be used wherever possible to accommodate such flow paths.

The EA states that ground floor levels should be a minimum (in relation to Ordnance Datum) of whichever is higher of:

- 300 mm above the general ground level of the site, or
- 600 mm above the estimated river or sea flood level

unless local guidance states otherwise.

The effectiveness of a flow management scheme within a single site is heavily limited by site constraints including (but not limited to) topography; geology and soil (permeability); development density; existing drainage networks both onsite and in the surrounding area; adoption issues; and available area. The design, construction and ongoing maintenance regime of such a scheme must be carefully defined at an early stage and a clear and comprehensive understanding of the catchment hydrological processes (i.e. nature and capacity of the existing drainage system) is essential.

6.9 Property Flood Resilience (PFR)[19]

PFR measures should only be applied retrospectively to existing development that is at flood risk, as new development should not be constructed in areas at flood risk. Para 167 of the NPPF explains that development must only be allowed in areas at flood risk where, following the Sequential and Exception Tests, and supported by an FRA, the development is appropriately flood resistant and resilient.

Flood resilience and resistance measures are mainly designed to mitigate flood risk and reduce damage and adverse consequences to existing property. Resistance and resilience measures may aim to help residents and businesses recover more quickly following a flood event.

[19] https://www.ciria.org/Resources/Free_publications/CoP_for_PFR_resource.aspx

It should be noted that it is not possible to completely prevent flooding to all communities and businesses.

Research carried out by the then DCLG (now the MHCLG) and the EA has recommended that the use of resistance measures should generally be limited to a nominal protection height of 600 mm above ground level, in relation to Ordnance Datum, the lowest point of ground abutting the external property walls. This is because the structural integrity of the property may be compromised above this level. The EA have standing advice in relation to resistance and resilience measures available via:

https://www.gov.uk/guidance/flood-risk-assessment-standing-advice#extra-flood-resistance-and-resilience-measures

It should be noted that PFR measures would not be expected to cause an increase in flood risk to other properties or other parts of the local community. They will help mitigate against flood risk but, as with any flood alleviation scheme, flood risk cannot be removed completely. Emergency plans should, therefore, be in place that describe the installation of measures and residual risks.

As the flood risk posed to a property cannot be removed completely, it is recommended that PFR products are deployed in conjunction with pumps of a sufficient capacity. Pumps help manage residual flood risks not addressed by resistance measures alone such as rising groundwater.

6.9.1 Definitions

Flood resilience measures aim to reduce the damage caused by floodwater entering a property. Flood resilience measures are based on an understanding that internal flooding may occur again and when considering this eventuality, homes and businesses are encouraged to plan for flooding with an aim of rapid recovery and the return of the property to a habitable state.

For example, tiled floors are easier to clean than carpets, raised electricity sockets and high-level wall fixings for TVs / computers may mean that that power supply remains unaffected. Raising kitchen or storage units may also prevent damage that may not require replacement after a flood. There is a lot of information available about what items get damaged by floodwater and features that are considered to provide effective resilience measures that can be installed at a property.

Flood resistance measures aim to reduce the amount of floodwater entering the property. Obvious inflow routes, such as through doors and airbricks may be managed, for example, by installing bespoke flood doors, door flood barriers and automatic closing airbricks. However, the property's condition and construction are also key to understanding how floodwater may enter and move between buildings. For example, flood water can also flow between properties through connecting cavity walls, cellars, beneath suspended floors and through internal walls. Flood resistance measure alone may not keep floodwater out. Building condition is a critical component of any flood mitigation study.

6.9.2 Property mitigation surveys

To define the scale and type of resistance or resilience measures required, a survey will need to be undertaken to pick up property threshold levels, air brick levels, doorways, historic flood levels and a number of ground spot levels required to better understand the flood mechanisms for flood water arriving at the property (e.g. along road, pavements, etc.). The depth of flooding at each property will help guide the selection of resistance measures proposed. Surveys will need to include consideration of issues such as:

- Detailed property information
- An assessment of flood risk, including property (cross) threshold levels

- Routes of water ingress (fluvial, ground and surface water flooding)
- An assessment of the impact of flood waters
- A schedule of measures to reduce risk (resistance and resilience)
- Details of recommendations (including indicative costs)
- Advice on future maintenance of measures
- Advice on flood preparedness

All sources of flooding will need to be considered, including a comprehensive survey of openings (doors, windows and air bricks), as well as potential seepage routes through walls and floors, ingress through service cables, pipes, drains and identify possible weaknesses in any deteriorating brickwork or mortar.

7 Emergency Planning

The provisions for emergency planning for local authorities as Category 1 responders are set out by the Civil Contingencies Act, 2004 and the National Flood Emergency Framework for England, December 2014[20]. This framework is a resource for all involved in emergency planning and response to flooding from the sea, rivers, surface water, groundwater and reservoirs. The Framework sets out Government's strategic approach to:

- Ensuring all delivery bodies understand their respective roles and responsibilities when planning for and responding to flood related emergencies;
- Giving all players in an emergency flooding situation a common point of reference which includes key information, guidance and key policies;
- Establishing clear thresholds for emergency response arrangements;
- Placing proper emphasis on the multi-agency approach to managing flooding events;
- Providing clarity on the means of improving resilience and minimising the impact of flooding events;
- Providing a basis for individual responders to develop and review their own plans; and
- Being a long-term asset that will provide the basis for continuous improvement in flood emergency management.

Along with the EA flood warning systems, there are a range of flood plans at a sub-regional and local level, outlining the major risk of flooding and the strategic and tactical response framework for key responders. The EA and the Association of Directors of Environment, Economy, Planning and Transport (ADEPT) have produced guidance on flood risk emergency plans for new development[21] (September 2019).

This SFRA contains useful data to allow emergency planning processes to be tailored to the needs of the area and be specific to the flood risks faced. The SFRA Maps in Appendix A and accompanying GIS layers should be made available for consultation by emergency planners during an event and throughout the planning process.

7.1 Civil Contingencies Act

Under the Civil Contingencies Act (CCA, 2004)[22], local authorities are classified as Category 1 responders and thus have duties to assess the risk of emergencies occurring, and use this to:

- Inform contingency planning;
- Put in place emergency plans;
- Put in place business continuity management arrangements;
- Put in place arrangements to make information available to the public about civil protection matters;
- Maintain arrangements to warn, inform and advise the public in the event of an emergency;
- Share information with other local responders to enhance coordination; and

[20] https://www.gov.uk/government/publications/the-national-flood-emergency-framework-for-england
[21] https://www.adeptnet.org.uk/floodriskemergencyplan
[22] https://www.gov.uk/preparation-and-planning-for-emergencies-responsibilities-of-responder-agencies-and-others#the-civil-contingencies-act

- Cooperate with other local responders to enhance coordination and efficiency and to provide advice and assistance to businesses and voluntary organisations about business continuity management.

During an emergency, such as a flood event, the local authority must also co-operate with other Category 1 responders (such as the emergency services and the EA) to provide the core response.

7.1.1 Lancashire Resilience Forum[23] (LRF)

The aim of the LRF is to legally deliver the duties stated in the Civil Contingencies Act 2004 within a multi-agency environment. The LRF is a group of organisations that work together to prepare and respond to emergencies in Lancashire. The LRF involves local authorities, emergency services, health agencies, the EA and local businesses.

The LRF's common objectives are to:

- Prevent the situation from getting worse;
- Save lives;
- Relieve suffering;
- Protect property;
- Recover to normality as soon as possible;
- Facilitate criminal investigation and judicial process as necessary.

The LRF's main roles include:

- Assessing the impacts of the risk and providing this information to the public in a Community Risk Register;
- Creating emergency plans
- Responding together in a coordinated way
- Training and testing for preparedness
- Learning the lessons from incidents and exercises.

7.1.2 Community Risk Register[24]

The LRF produces the Community Risk Register (CRR) which lists possible risks, the probability of occurring and potential impact. The CRR provides information on the biggest emergencies that happen in Lancashire, together with an assessment of how likely they are to happen and the impacts if they do include impacts to people, houses, the environment and local businesses. Each identified risk is then analysed and given a rating according to how likely the risk is to lead to an emergency and their potential impact on safety and security, health, economy, environment and society.

7.1.3 Community Emergency Plan

Communities may need to rely on their own resources to minimise the impact of an emergency, including a flood, before the emergency services arrive. Many communities already help each other in times of need, but experience shows that those who are prepared cope better during an emergency. Communities with local knowledge, enthusiasm and information are a great asset and a Community Emergency Plan can help. Details on how to produce a community emergency plan, including a toolkit and template, are available from the Government's website[25].

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[23] https://www.stayintheknow.co.uk/EmergencyInfo
[24] https://www.lancashire.gov.uk/council/strategies-policies-plans/emergency-planning/risks-in-lancashire/
[25] https://www.gov.uk/guidance/resilience-in-society-infrastructure-communities-and-businesses#community-resilience

7.1.4 LCiC flooding emergency planning information

LCiC maintains a webpage dedicated to emergency planning for the public in the event of a flood, including:

- how to prepare for a flood
- what to do during a flood
- what to do after a flood
- advice for businesses
- local sandbag suppliers
- links to the Lancaster City Council Multi-Agency Flooding Plan
- and the Lancaster City Council Severe Weather Plan

http://www.lancaster.gov.uk/environmental-health/emergency-planning/flooding-how-to-prepare-and-what-to-do-if-you-have-been-affected

7.1.5 Local flood plans

This SFRA provides a number of flood risk data sources that should be used when producing or updating flood plans. The LPA will be unable to write their own specific flood plans for new developments at flood risk. Developers should write their own. Generally, owners with individual properties at risk should write their own individual flood plans, however larger developments or regeneration areas, such as retail parks, hotels and leisure complexes, should consider writing one collective plan for the assets within an area.

This SFRA can help to:

- Update these flood plans if appropriate;
- Inform emergency planners in understanding the possibility, likelihood and spatial distribution of all sources of flooding (emergency planners may however have access to more detailed information, such as for Reservoir Inundation Maps, which have not been made available for this SFRA);
- Identify safe evacuation routes and access routes for emergency services;
- Identify key strategic locations to be protected in flooding emergencies, and the locations of refuge areas which are capable of remaining operational during flood events;
- Provide information on risks in relation to key infrastructure, and any risk management activities, plans or business continuity arrangements;
- Raise awareness and engage local communities such as local community Flood Action Groups. The EA is working closely with Lancaster City Council who have been proactive in supporting new Community Groups following the floods of December 2015;
- Support emergency responders in planning for and delivering a proportionate, scalable and flexible response to the level of risk; and
- Provide flood risk evidence for further studies.

The following guidance written by the EA and ADEPT is aimed at LPAs to help assist in setting up guidelines on what should be included in the flood risk emergency plans:

https://www.adeptnet.org.uk/floodriskemergencyplan

7.2 Flood warning and evacuation plans

Developments that include areas that are designed to flood (e.g. ground floor car parking and amenity areas) or have a residual risk associated with them, will need to provide appropriate flood warning and instructions so users and residents are safe in a

flood. This will include both physical warning signs and written flood warning and evacuation plans. Those using the new development should be made aware of any evacuation plans.

In relation to new development it is up to the LPA to determine whether the flood warning and evacuation plans, or equivalent procedures, are sufficient or not. If the LPA is not satisfied, taking into account all relevant considerations, that an indicative development can be considered safe without the provision of safe access and exit, then planning permission should be refused.

Whilst there is no statutory requirement on the EA or the emergency services to approve evacuation plans, LPAs are accountable under their Civil Contingencies duties, via planning condition or agreement, to ensure that plans are suitable. This should be done in consultation with development management officers. Given the cross-cutting nature of flooding, it is recommended that further discussions are held internally to the LPA between emergency planners and policy planners / development management officers, the LLFA, drainage engineers and also to external stakeholders such as the emergency services, the EA, UU, Internal Drainage Boards and Canal & River Trust (if applicable).

It may be useful for both the LLFA and spatial planners to consider whether, as a condition of planning approval, flood evacuation plans should be provided by the developer which aim to safely evacuate people out of flood risk areas, using as few emergency service resources as possible. Lancashire Local Resilience Forum are essential to establish the feasibility / effectiveness of such an approach, prior to it being progressed. It may also be useful to consider how key parts of agreed flood evacuation plans could be incorporated within local development documents, including in terms of protecting evacuation routes and assembly areas from inappropriate development.

Once the development goes ahead, it will be the requirement of the plan owner (developer) to make sure the plan is put in place, and to liaise with the LPA and LLFA regarding maintenance and updating of the plan.

7.2.1 What should the Plan include?

Flood warning and evacuation plans should include the information stated in Table 7-1. Advice and guidance on plans are accessible from the EA website and there are templates available for businesses and local communities.

Consideration	Purpose
Availability of existing flood warning system	The EA offers a flood warning service that currently covers designated Flood Warning Areas in England and Wales. In these areas, they are able to provide a full Flood Warning Service.
Rate of onset of flooding	The rate of onset is how quickly the water arrives and the speed at which it rises which, in turn, will govern the opportunity for people to effectively prepare for and respond to a flood. This is an important factor within Emergency Planning in assessing the response time available to the emergency services.
How flood warning is given and occupants awareness of the likely frequency and duration of flood events.	Everyone eligible to receive flood warning should be signed up to the EA flood warning service. Where applicable, the display of flood warning signs should be considered. In particular sites that will be visited by members of the public on a daily basis such as sports complexes, car parks, retail stores. It is envisaged that the responsibility should fall upon the developers and should be a condition of the planning

Consideration	Purpose
	permission. Information should be provided to new occupants of houses concerning the level of risk and subsequent procedures if a flood occurs.
The availability of staff / occupants / users to respond to a flood warning and the time taken to respond to a flood warning	The plan should identify roles and responsibilities of all responders. The use of community flood wardens should also be considered.
Designing and locating safe access routes, preparing evacuation routes and the identification of safe locations for evacuees	Dry routes will be critical for people to evacuate as well as emergency services entering the site. The extent, depth and flood hazard rating, including allowance for climate change, should be considered when identifying these routes.
Vulnerability of occupants	Vulnerability classifications associated with development as outlined in the FRCC-PPG. This is closely linked to its occupiers.
How easily damaged items will be relocated, and the expected time taken to re-establish normal use following an event	The impact of flooding can be long lasting well after the event has taken place affecting both the property which has been flooded and the lives that have been disrupted. The resilience of the community to get back to normal will be important including time taken to repair / replace damages.

Table 7-1: Flood warning and evacuation plans

7.2.2 EA Flood Warning Areas (FWA) and flood awareness

The EA monitors river levels within the Main Rivers across England and, based upon weather predictions provided by The Met Office, make an assessment of the anticipated maximum water level that is likely to be reached within the proceeding hours (and/or days). Where these predicted water levels are expected to result in inundation of a populated area, the EA will issue a series of flood warnings within a defined FWA, encouraging residents to take action to avoid damage to property in the first instance.

More information on flood warnings is provided by the EA via:

https://www.gov.uk/government/publications/flood-warnings-what-they-are-and-what-to-do

There are 28 FWAs in operation across the study area. The FWA's are located along the Rivers Lune, Wenning and Conder, Burrow Beck and the Lancashire coastline to protect the properties and businesses. The FWAs are shown on the SFRA maps in Appendix A.

Live information on flood warning and flood alerts for any location in England is available via:

https://flood-warning-information.service.gov.uk/

Emergency planners may also use the outputs from this SFRA to raise awareness within local communities. This should include raising awareness of flood risk, roles and responsibilities and measures that people can take to make their homes more resilient to flooding from all sources whilst also encouraging all those at fluvial and tidal flood risk to sign up to the EA's Flood Warning service.

https://www.gov.uk/sign-up-for-flood-warnings

It is also recommended that Category 1 responders are provided with appropriate flood response training to help prepare them for the possibility of a major flood with an increased number of people living within flood risk areas, to ensure that adequate pre-planning response and recovery arrangements are in place.

8 Summary and Recommendations

8.1 Summary

This Level 1 SFRA provides a single repository planning tool relating to flood risk and development across the Lancaster City Council administrative area. Key flood risk stakeholders namely the EA, LLFA, UU, local emergency services, emergency planners, local resilience forums and the neighbouring authorities of Craven and South Lakeland were consulted to collate all available and relevant flood risk information on all sources into one comprehensive assessment. Together with this main report, this SFRA also provides a suite of interactive GeoPDF flood risk maps (Appendix A) and a development site assessment spreadsheet (Appendix B) illustrating the level of risk to potential development sites.

The flood risk information, assessment, guidance and recommendations provided in this SFRA will provide the LPA with the evidence base to inform the preparation of policies in the Climate Emergency Local Plan Review.

This SFRA therefore provides the necessary links between spatial development, wider flood risk management policies, local strategies and plans and on the ground works by combining all available flood risk information together into one single repository. As this is a strategic study based on current available information, detailed, site-specific local information on flood risk is not fully accounted for. For a more detailed assessment of specific areas or sites, a site-specific FRA's will accompany most planning applications.

The data and information used throughout the SFRA process is the most up-to-date data available at the time of preparation. Once new, updated or further flood risk or policy information becomes available, the LPA should look to update this SFRA. The Level 1 SFRA should be considered, and maintained as, a 'live' entity which is updated as and when required (when new modelling or flood risk information becomes available). The LPA and LLFA can decide when to update the SFRA, and the EA as a statutory consultee on local plans can also advise the LPA to update the SFRA.

8.1.1 Summary of risk

The risk across the LCiC administrative area is varied:

- The main fluvial risk comes from:
  - the River Lune that flows into the Lancaster District from South Lakeland to the north of the council boundary, affecting Tunstall, Caton, Halton and parts of Lancaster City Centre.
  - the River Wenning, a tributary of the River Lune, in the east of Lancaster affecting Wennington and Hornby.
  - the River Conder in the south of the district affecting Galgate.
  - the River Keer in the north of the district, affecting Millhead and Warton.
- There is extensive tidal risk along the whole coastline with areas most at risk in Morecambe and the along the Lune estuary.
- Surface water risk is spread across the whole of the Lancaster district. The main areas of risk are primarily centred around the Main Rivers; particularly in the Lune and Keer river valleys and the coast around Morecambe and Lancaster.
- The areas with the highest levels of groundwater vulnerability are located primarily in the southern section of the council boundary affecting areas such as Galgate, Bailrigg, Lancaster City Centre and Conder Green. Other areas such as Morecambe, Carnforth and Tunstall are also vulnerable to groundwater flooding.

8.2 SFRA flood risk policy recommendations

Additional to LCiC's Local Plan policies on Water Management (see Appendix D), the following planning flood risk policy recommendations are designed to enable the LPA to use the information provided in this Level 1 SFRA to inform Local Plan policy direction:

Recommendation 1: No development within the functional floodplain…

…as per the National Planning Policy Framework and Flood Risk and Coastal Change Planning Practice Guidance, unless in exceptional circumstances such as for essential infrastructure, which must still pass the Exception Test, or where development is water compatible.

Development must not impede the flow of water within the functional floodplain nor should it reduce the volume available for the storage of floodwater. Sites within the functional floodplain may still be developable if the site boundary can be removed from the functional floodplain or the site can accommodate the risk on site and keep the area of functional floodplain free from development or obstruction and allowed to flow freely.

Refer to tables 1 to 3 of the FRCC-PPG.

Recommendation 2a: Consider surface water flood risk…

…with equal importance alongside fluvial and tidal risk including possible withdrawal, redesign or relocation for sites identified to be at significant surface water risk through this SFRA.

SuDS on all new development must adhere to industry standards and to the applicable runoff discharge rate and storage volume allowances stated by the LLFA.

Site-specific FRAs should always consider surface water flood risk management and options for onsite flood storage through appropriate SuDS. The LPA / LLFA must always be consulted during this process, as should UU and the EA, if required.

Recommendation 2b: Use of appropriately sourced SuDS…

…required for all developments of 5 or more residential units or major commercial development.

As per the NPPF, in terms of SuDS, development in areas at flood risk should only be permitted where SuDS are incorporated into the design, unless clear evidence demonstrates this would be inappropriate.

SuDS scoping and design, as part of a site-specific FRA, must be included within the early stages of the site design in order to incorporate appropriate SuDS within the development.

The LPA, LLFA, UU (if appropriate) must be consulted during the site design stage and the FRA must be submitted to and approved by the LPA, considering all consultation with key stakeholders.

Consideration and preference should be given to Green SuDS features such as swales, attenuation ponds, detention basins etc. rather than oversized pipes and underground storage to bring wider amenity benefits as well as addressing flood risk / water management.

All SuDS must be designed to meet industry standards, as specified below, including any replacement standards/documents which update or are in addition to those listed:

- Local SuDS Guidance
- Interim national standards published in March 2015
- Technical Standards for Sustainable Drainage Systems (Defra)
- C753 The SuDS Manual
- Design and Construction Guidance (DCG)

Recommendation 3: Sequential approach to site layout…

…must be followed by the LPA to ensure sustainable development when either allocating land in Local Plans or determining planning applications for development.

The overall aim of the Sequential Approach should be to steer new development to low risk Flood Zone 1. Where there are no reasonably available sites in Flood Zone 1, the flood risk vulnerability of land uses and reasonably available sites in Flood Zone 2 should be considered, applying the Exception Test if required.

Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in higher risk Flood Zone 3a, be considered. This should take into account the flood risk vulnerability of land uses, residual surface water and/or groundwater flood risk and the likelihood of meeting the requirements of the Exception Test, if required.

This SFRA, the NPPF and FRCC-PPG must be consulted throughout this process along with the LPA, LLFA, EA, and UU if appropriate.

Recommendation 4: Requirement for a site-specific Flood Risk Assessment…

…from a developer when a site is:

- Located in Flood Zone 2 or 3
- Greater than 1 hectare in size
- Within Flood Zone 1 where any part of the site is identified by the RofSW flooding maps as being at risk of surface water flooding
- Identified by the EA as having critical drainage problems (within an Area with Critical Drainage Problems)
- Situated over or within 8 metres of a culverted watercourse or where development will be required to control or influence the flow of any watercourse
- Identified as being at increased flood risk in future
- At risk of flooding from other sources of flooding or at residual risk
- Subject to a change of use to a higher vulnerability classification which may be subject to other sources of flooding
- Situated in an area currently benefitting from defences
- Any site identified in the Cumulative Impact Assessment

Before deciding on the scope of the FRA, this SFRA should be consulted along with the LPA, LLFA, and UU. The FRA should be submitted to and be approved by the LPA including suitable consultation with the LLFA and the EA and any other applicable parties.

Recommendation 5: Natural Flood Management techniques…

…must be considered, where possible, to aid with flood alleviation and implementation of suitable SuDS, depending on the location.

The Council's GBI Strategy and the national Working with Natural Processes mapping (included in this SFRA) should be consulted in the first instance, followed by local investigation into whether such techniques are appropriate and whether the benefits are proportionate to the work required to carry out the identified Working with Natural Processes approaches.

Natural drainage features should be maintained and enhanced and there should be a presumption against culverting of open watercourses. Where possible, culvert removal should be explored.

Recommendation 6: Phasing of development…

…must be carried out by the LPA on a site by site basis and also within larger sites by the developer to avoid any cumulative impacts of flood risk (reinforced by the NPPF).

Using a phased approach to development, should ensure that any sites at risk of causing flooding to other sites are developed first to ensure that flood storage measures are in place and operational before other sites are developed, thus contributing to a sustainable approach to site development during all phases of construction. It may be possible that flood mitigation measures put in place at sites upstream could alleviate flooding at downstream or nearby sites.

Development phasing within large strategic sites of multiple developments should also be considered where parts of such sites are at flood risk.

Recommendation 7: Planning permission for at risk sites…

…can only be granted by the LPA where a site-specific FRA shows that:

- The requirements of the NPPF and FRCC-PPG have been followed and referenced together with appropriate consultation with the LLFA, the EA, and UU, where applicable
- The effects of climate change have been considered using the latest EA allowances
- There is no loss in floodplain storage resulting from the development i.e. where development takes place in a fluvial flood zone or is at risk from surface water flooding, compensatory storage must be found to avoid loss of floodplain and subsequent displacement of water which may cause flooding elsewhere
- The development will not increase flood risk elsewhere particularly where it has been shown, through the cumulative impact assessment of this Level 1 SFRA, that there is a high risk of cumulative impacts on downstream sites. Such sites should be subject to positive betterment on runoff volumes
- For previously developed sites, the development should look to meet greenfield runoff rates where practicable (in line with the Non-Statutory Technical Standards for Sustainable Drainage (March 2013)), achieved through providing Sustainable Drainage Systems as appropriate or through the use of appropriate flow and volume control devices.
- There is no adverse effect on the operational functions of any existing flood defence infrastructure
- Proposed resistance / resilience measures designed to deal with current and future risks are appropriate
- Whether the development will be safe for its lifetime and has passed the Exception Test, if applicable
- Appropriate SuDS techniques have been considered and are to be incorporated into the design of the site, where applicable
- An appropriate Emergency Plan is included that accounts for the possibility of a flood event and shows the availability of safe access and egress points accessible during times of flood.

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8.2.1 Recommendations for further work

The SFRA process has developed into more than just a planning tool. Sitting alongside the SA, LFRMS and FRMP, it can be used to provide a much broader and inclusive vehicle for integrated, strategic and local flood risk management and delivery.

There are a number of plans and assessments listed in Table 8-1 that may be of benefit to the LPA, in developing their flood risk evidence base to support the delivery of the Local Plan, or to the LLFA to help fill critical gaps in flood risk information that have become apparent through the preparation of this Level 1 SFRA.

Type	Study	Reason	Timeframe
Understanding of local flood risk	Level 1 SFRA update	When there are changes to: • the predicted impacts of climate change on flood risk • detailed flood modelling - such as from the EA or LLFA • the local plan, spatial development strategy or relevant local development documents • local flood management schemes • flood risk management plans • shoreline management plans • local flood risk management strategies • national planning policy or guidance Or after a significant flood event.	As required
	Level 1 SFRA update; Level 2 SFRA; site-specific FRA	Reviewing of EA flood zones in those areas not covered by existing detailed hydraulic models i.e. the Flood Map for Planning does not cover every watercourse such as those <3km^2 in catchment area or Ordinary Watercourses. If a watercourse or drain is present on OS mapping but is not covered by the Flood Map for Planning, this does not mean there is no potential flood risk. A model may therefore be required to ascertain the flood risk, if any, to any nearby sites.	Short term
	Level 2 SFRA	LPA may be required to carry out further, more detailed assessment of flood risk to high risk sites, large strategic sites, as notified by this Level 1 SFRA in order to allocate.	Short term
	Preliminary site-screening FRAs / outline drainage strategy	Further, more detailed assessment of larger strategic sites.	Short term
	Local Flood Risk Management Strategy Review	It is recommended that the LFRMS is updated to ensure it remains consistent with the National Flood and Coastal Erosion Risk Management Strategy that was updated and published July 2020.	Short term
	Water Cycle Study	LCiC has not developed a WCS for the district. If a future Local Plan highlights large growth	As evidence for future

Type	Study	Reason	Timeframe
		and urban expansion, the council should look to produce a WCS to look at capabilities of water and sewerage providers.	local plan allocations
Flood storage and attenuation	Community Infrastructure Levy (CIL) and Green Infrastructure (GI)	For new developments, GI assets can be secured from a landowner's 'land value uplift' and as part of development agreements. The LPA could include capital for the purchase, design, planning and maintenance of GI within its CIL programme.	Short term
	Level 2 SFRA cumulative impacts assessment	Identify, and then protect from development, sites suitable for flood storage in catchments at high risk further downstream.	Short term
	Working with Natural Processes	Promote creation of floodplain and riparian woodland, floodplain reconnection and runoff attenuation features where the research indicates that it would be beneficial in Lancaster.	Ongoing
Data collection	Flood Incident data	LCoC, as LLFA, has a duty to investigate and record details of significant flood events within their area. General data collected for each incident, should include date, location, weather, flood source (if apparent without an investigation), impacts (properties flooded or number of people affected) and response by any Risk Management Authority.	Short term
	FRM Asset Register	LCoC has a responsibility to update and maintain a register of structures and features, which are considered to have an effect on flood risk.	Ongoing
Risk Assessment	Asset Register Risk Assessment	LCoC, as LLFA, should carry out a strategic flood risk assessment of structures and features on the Asset Register to inform capital programme and prioritise its maintenance programme.	Short Term / Ongoing
	Coastal Asset Maintenance	LCiC should consult with the Environment Agency on the condition of assets rated 'Poor' and 'Very Poor' e.g. through inspections, in order to prioritise maintenance of assets.	Short Term
Capacity	SuDS review / guidance	The LLFA should clearly identify its requirements of developers for SuDS in new developments. Internal capacity, within LCoC should be in place to deal with SuDS applications, set local specification and set policy for adoption and future maintenance of SuDS.	Short Term / Long Term
Partnership	United Utilities	The LLFA should continue to collaborate with UU on sewer and surface water projects. The LPA should be kept informed and carry out an assessment of water company assets to ensure they are operational and resilient at all times	Ongoing

Type	Study	Reason	Timeframe
		across the catchment and that capacity for new development is appropriate.	
	EA	LCiC should continue to work with the EA on fluvial flood risk management projects. Potential opportunities for joint schemes to tackle flooding from all sources should be identified.	Ongoing
	Community	Continued involvement with the community through LCiC's existing flood risk partnerships.	Ongoing

Table 8-1: Recommended further work for LCiC, LCoC or developers

Appendices

A SFRA Maps

Interactive GeoPDF maps

The SFRA Maps consist of all flood risk information used within the SFRA, by way of interactive GeoPDFs. Open the Overview Map in Adobe Acrobat. The Overview Map includes a set of five squares; clicking on one of these squares will open up on of the Index Maps. The Index Maps then contains a set of index squares covering the authority area at a scale of 1:10,000. Clicking on one of these index squares will open up a more detailed map of that area (scale = 1:10,000) by way of a hyperlink.

Within the detailed maps, use the zoom tools and the hand tool to zoom in/out and pan around the open detailed map. In the legend on the right-hand side of the detailed maps, layers can be switched on and off when required by way of a dropdown arrow. The potential development site reference labels can also be switched on and off if, for example, smaller sites are obscured by labels.

The table below lists the datasets that are included in the maps with a short description of what they show.

Dataset	Description
Areas Benefitting from Defences	This dataset shows those areas that benefit from the presence of defences in a 1 in 100 (1% AEP) chance of flooding each year from rivers; or 1 in 200 (0.5% AEP) chance of flooding each year from the sea. Note: in mapping these areas, it is assumed that flood defences and other operating structures act perfectly and give the same level of protection as when the assessment of the area was done.
BGS Potential for Groundwater Flooding map	Dataset from the British Geological Survey shows which areas are susceptible to groundwater flooding classified into three categories.
Council Boundary	A shapefile showing LCiC's administrative area.
Climate Change Modelled Flood Outlines	Climate change modelled flood outlines from the EA hydraulic models provided by the EA for this SFRA.
Flood Alert Areas	Geographical areas where it is possible for flooding to occur from rivers, sea and, in some locations, groundwater. Flood Alerts are issued to warn people of the possibility of flooding and encourage them to be alert, stay vigilant and make early/low impact preparations for flooding.
Flood Storage Areas	Geographical areas that act as a balancing reservoir, storage basin or balancing pond with a purpose to attenuate an incoming flood peak to a flow level that can be accepted by the downstream channel.
Flood Warning Areas	Geographical areas where we expect flooding to occur and where the Environment Agency provide a Flood Warning Service.
Flood Zone 3b (functional floodplain)	The functional floodplain was delineated as part of this SFRA (see Appendix D for methodology note) as it is not included in the Flood Map for Planning. This zone is for the use of LPAs and developers.
Flood Zones 2 and 3	The flood zones that are included within the Environment Agency's Flood Map for Planning. Note: Flood Zone 3b was delineated so Flood Zone 3 is therefore classed as Flood Zone 3a.
Recorded Flood Outlines	Dataset from the Environment Agency showing all records of historic flooding from rivers, the sea, groundwater and surface

Dataset	Description
	water. This dataset contains a consistent list of information about the recorded flood.
Historic Flood Map	Dataset from the Environment Agency showing the maximum extent of all individual Recorded Flood Outlines from river, the sea and groundwater. It differs from the Recorded Flood Outlines dataset as the HFM only contains outlines that are 'considered and accepted'.
Main Rivers	Dataset from the Environment Agency of the designated Main Rivers that the EA has permissive powers to carry out maintenance, improvement and construction work.
Main River buffer	EA guidance states that a buffer is required along all watercourses, which may be needed for access, maintenance or future flood risk management to make sure development in these areas does not increase flood risk. An 8-metre buffer, either side of each watercourse, has therefore been used in this SFRA, based on typical EA advice. Note: this buffer area is indicative and any plans for development should, through an FRA, further investigate the area required for the buffer zone.
Risk of Flooding from Rivers and Sea (RoFRS)	Dataset from the Environment Agency showing the chance of flooding from rivers and/or the sea, based on cells of 50 metres. Each cell is allocated one of four flood risk categories, taking into account flood defences and their condition.
Risk of Flooding from Surface Water (RoFSW)	Previously known as the updated Flood Map for Surface Water (uFMfSW); shows the extent of flooding from surface water that could result from a flood. Note: this data should not be used for property level investigations.
Spatial Flood Defences	Dataset from the Environment Agency showing all flood defences currently owned, managed or inspected by the EA. It has been symbolised to show raised flood walls and embankments within the study area.
Working with Natural Processes	There are 6 shapefiles located on the maps showing working with natural processes interventions that can be used as more natural forms of flood management.
United Utilities boundary	A shapefile of UU's administrative area.

B Development Site Assessment Spreadsheet

Excel spreadsheet containing an assessment of flood risk to the allocations based on fluvial and tidal Flood Zones 1, 2, 3a and 3b; the Risk of Flooding from Surface Water; and modelled climate change considerations for fluvial and tidal risk, where available.

C Sites assessment summary

Accompanying the Development Site Assessment Spreadsheet in Appendix B, this Appendix provides a summary of the sites assessment process

D Planning framework and flood risk policy

Following the introduction to the planning framework and flood risk policy located in Section 4, the remainder of the policy information is located within this appendix and gives background into the policy documents that are relevant to LCiC.

E Functional floodplain update

Technical note explaining the methodology behind the updating of the functional floodplain (Flood Zone 3b)

F Indicative surface water flood risk from proposed development

Surface water runoff and attenuation requirements calculate for each allocation, including for climate change

G Level 1 SFRA User Guide

A support document to provide guidance on the use of the SFRA to developers, spatial planners, development management, flood risk management and emergency planners.

H Climate change modelling methodology

Climate Change Modelling Methodology Report

Technical Modelling Note

I Cumulative impact assessment methodology

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