

# **The use of Sustainable Drainage Systems (SuDS) and Natural Flood Management (NFM) measures to manage the increased flood risks in urban areas due to climate change**

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**Leicester City Council**



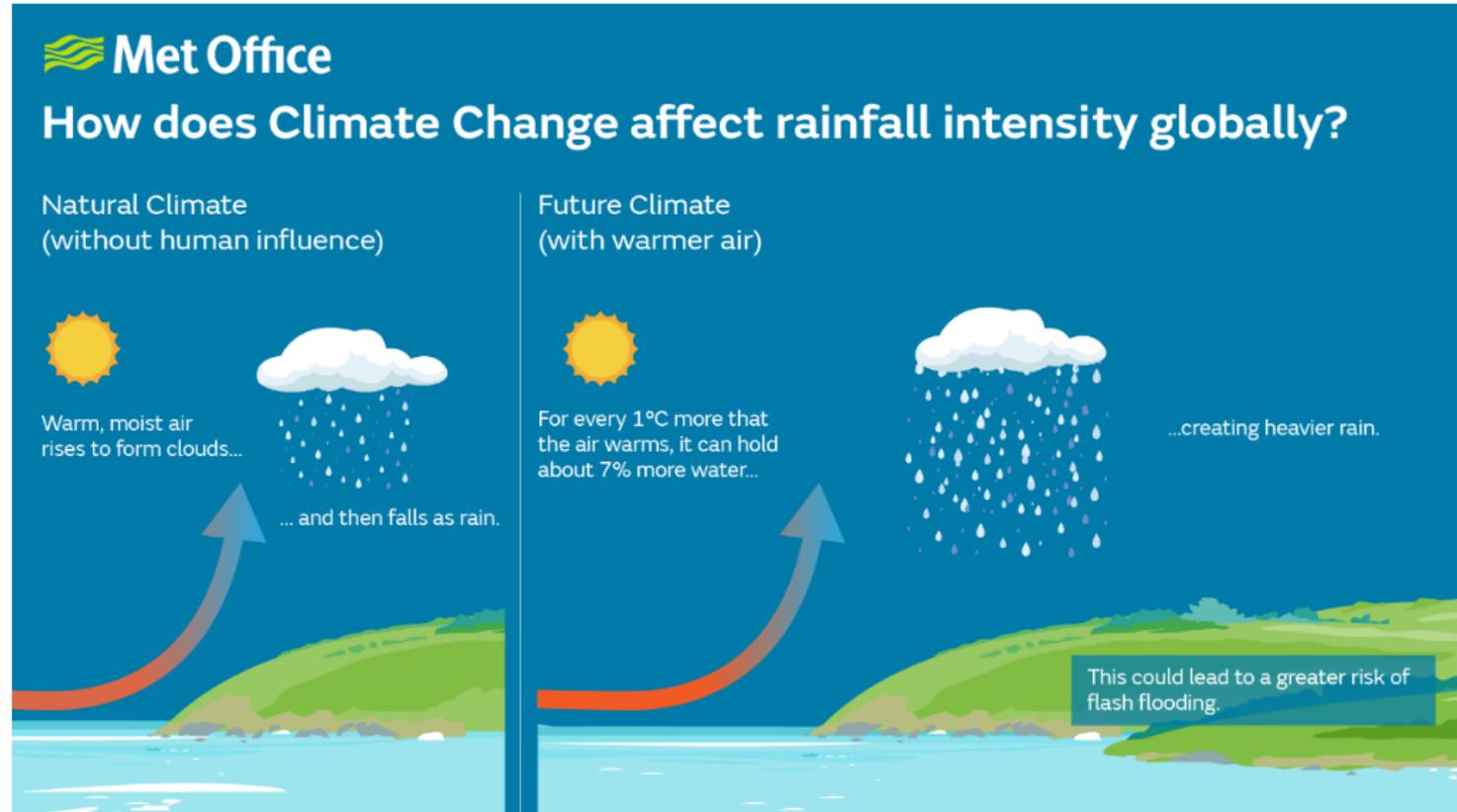
Leicester  
City Council

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# Background

- Urban areas and cities
- Climate Change
- Increased rainfall
- Saturated ground (urban parks)
- Flood risk
- SuDS and NFM measures



*Warmer air under climate change can create heavier rain.*

# Introduction to SuDS

- Manage rainwater from source
- Mimics natural drainage
- Attenuation feature
- Retrofit SuDS – urban areas

## Ecosystem Services:

- They are the benefits people receives directly or indirectly from the environment
- Supporting Services; Provisioning Services; Regulating Services; Cultural Services

## Types of SuDS:

- Infiltration SuDS
  - Soakaways
  - Infiltration basin
- Non-infiltration SuDS
  - Rain gardens/Bio-retention areas
  - Tree pits
  - Filter drains
  - Filter strips
  - Permeable paving
  - Swales
  - Detention basins
  - Retention pond
  - Wetland

# Mixed Method Research

- Physical methods (Visual Inspection, Pond and Wetland survey)
- Public Perception Survey (500 Surveys)
- Public Participatory Geographical Information System (PPGIS) (Community engagement)
- 3 Case study areas
  - Ardler, Dundee, Scotland
  - Dunfermline, Fife, Scotland
  - Waterlooville, Hampshire, England



# Ardler, Dundee – Pilot study

- Multiple regeneration happened in the village
- One of the first Scottish development with SuDS
- SuDS built in late 1990's



East Pond



West Pond

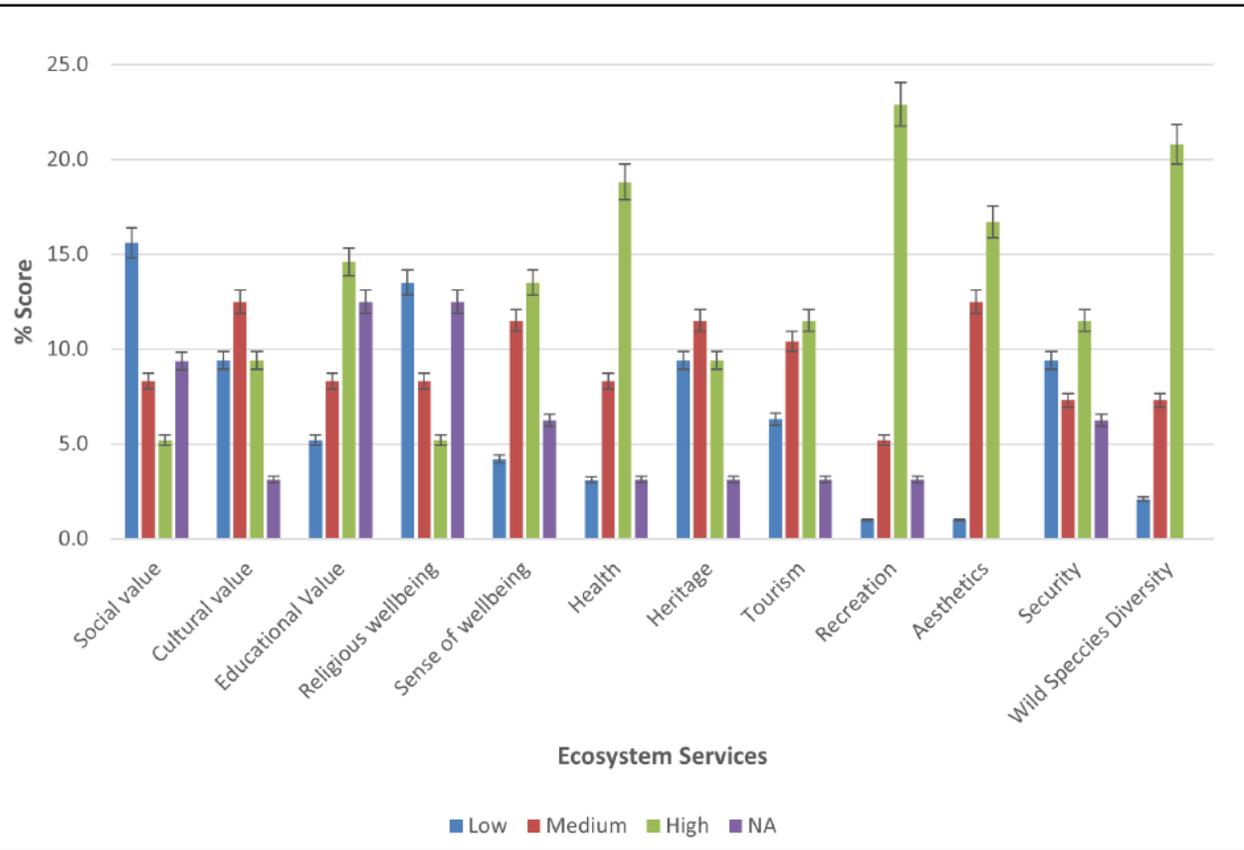


Swale



Detention Basin

# Ardler, Dundee – Contd



# Dunfermline, Fife – Main study area

- 500ha mixed development with well-established SuDS

Wetland



Swale



Masterton Lea Pond



Halbeath Pond

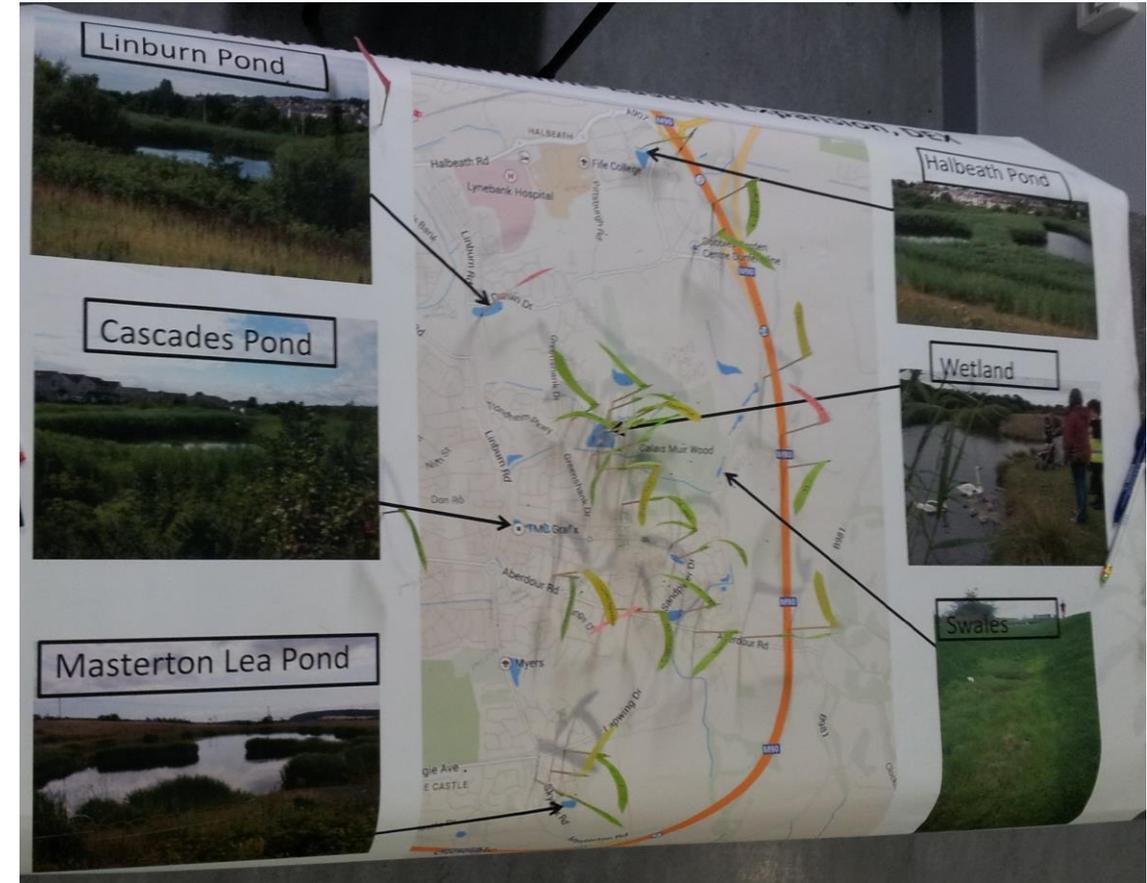
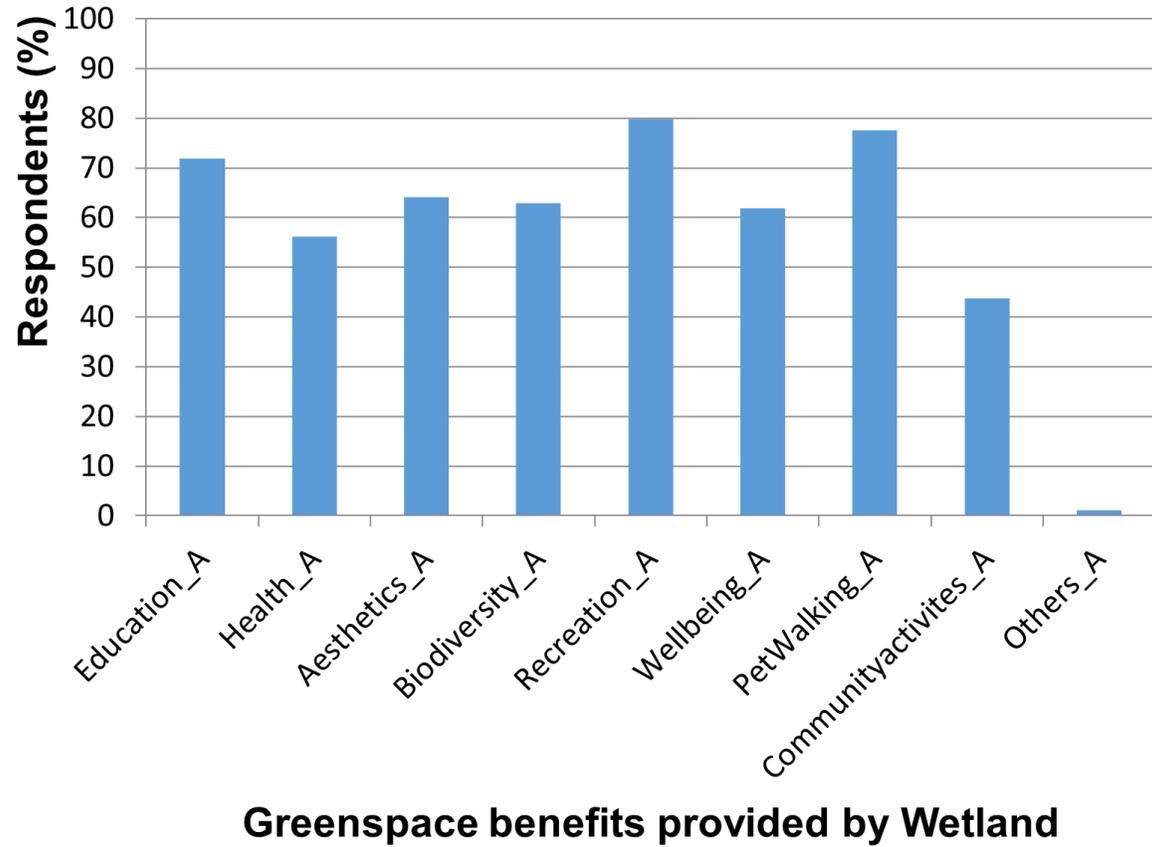


Linburn Basin



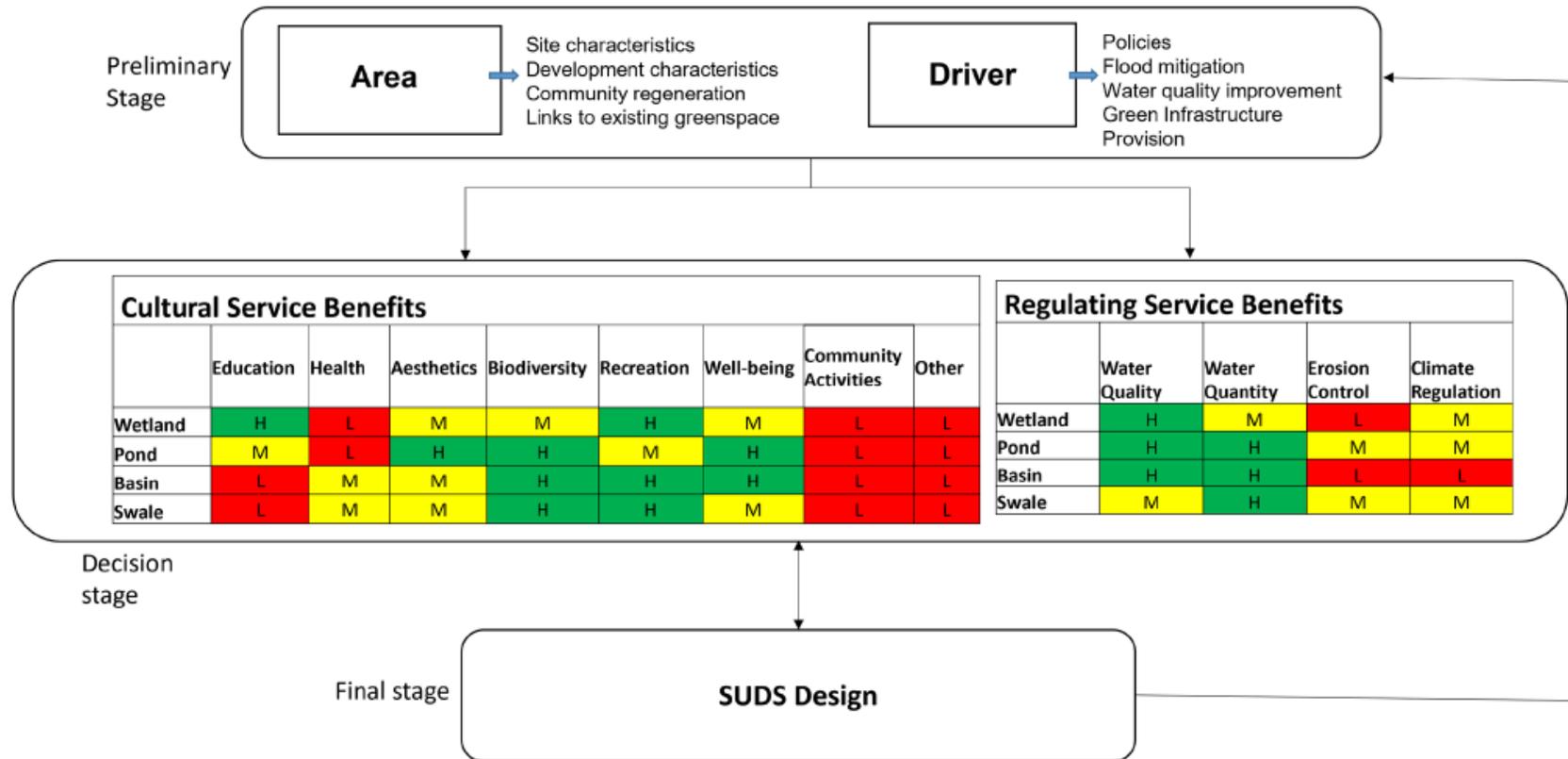
Linburn Pond

# Dunfermline, Fife – Contd



# Communication Tool

## Communication Tool for ecosystem services associated with SUDS



# Waterlooville, Hampshire – Test site

- 247ha
- Well-established SuDS
- Professional Survey to assess the communication tool:
  - Response rate: 56%
  - Respondents: 20% planner, 15% regulator, 15% SuDS designers; 10% consultants
  - Whether respondents agree with output of communication tool: Swale -75% ; pond 80%
  - Whether respondents opinion on ecosystem services benefits provided by SuDS changed after seeing communication too: 35% changes; 55% did not change
  - Whether ecosystem services benefits important for design of SuDS: High – 85%; Medium 15%
  - Rate communication tool: High - 30%; Medium - 45% ; low - 10%

Swale



Pond

# Research into Practice

- Organisations with SuDS responsibility within Leicester city council:
  - Lead Local Flood Authority
  - Local Planning Authority
  - Highways Authority
  - Parks Department
  - Building regulations
  - Property Department
- Organisations with SuDS responsibility outside the council:
  - Environment Agency
  - Severn Trent Water
  - Canal and River Trust
- Management companies
- SuDS Approval Body (SAB)

United Kingdom constituent countries	SuDS is a Statutory requirement	Legislation	Statutory Body
England	No	National Planning Policy Framework, Updated 2021. Flood and Water Management Act 2010 (Schedule 3)	–
Scotland	Yes	Controlled Activities Regulation, updated 2017. Water Environment and Water Services Act 2003. Schedule 3.	Scottish Water and Local Authorities with guidance and regulation from Scottish Environmental Protection Agency (SEPA)
Wales	Yes	Flood and Water Management Act 2010 (Schedule 3), 2019	SuDS Approval Body (SAB). Natural Resources Wales
Northern Ireland	Yes	Northern Ireland Planning Policy Statement 15. The Water and Sewerage Services Act (Northern Ireland), 2016	Northern Ireland Water

Reference: Jose and Wade, 2023.



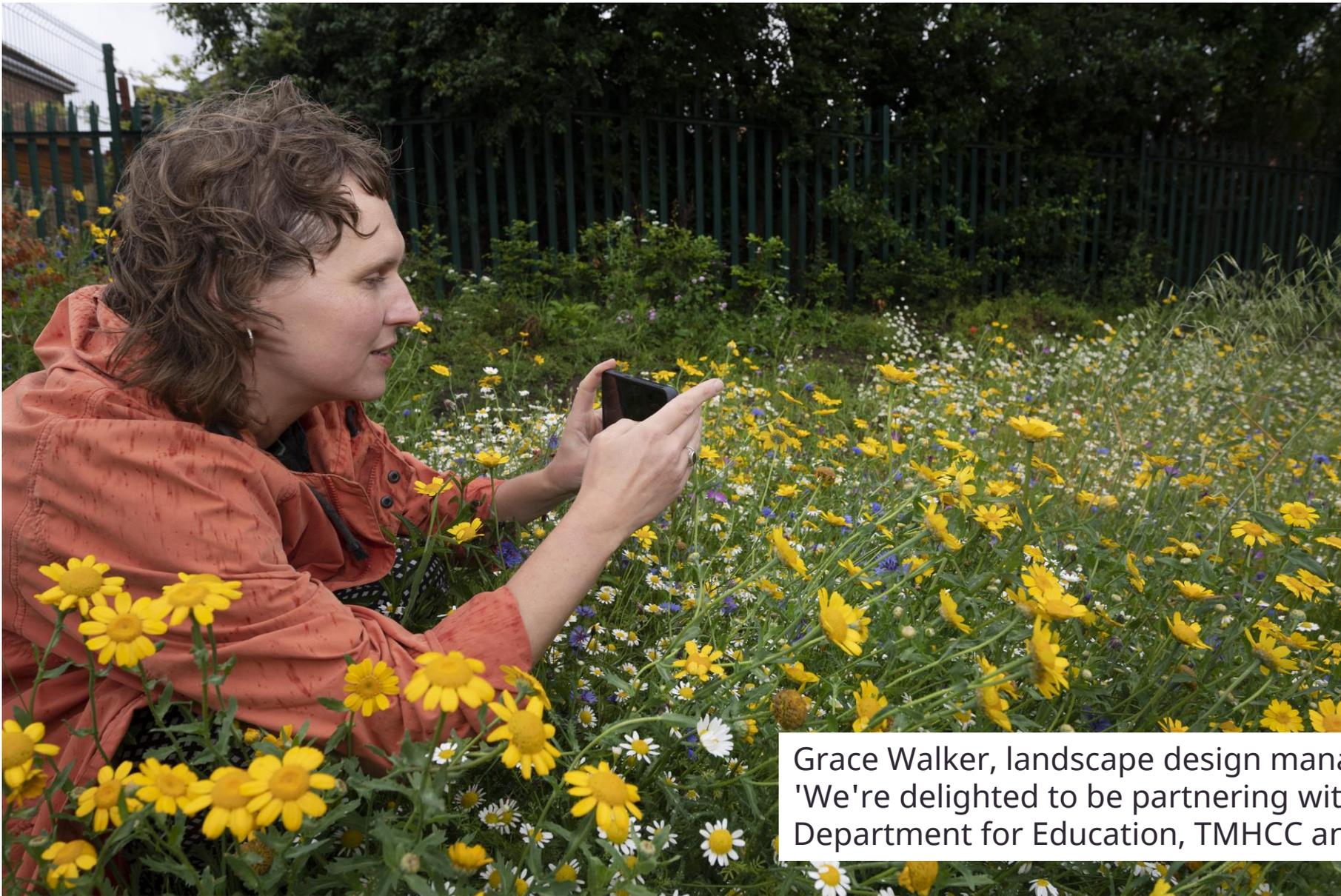
# SuDS in School project, Leicester



Department  
for Education

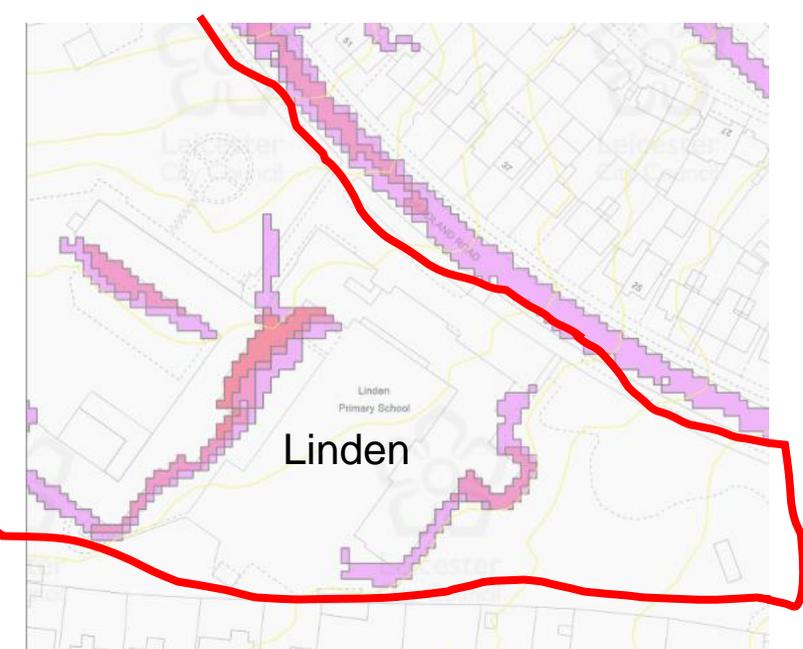
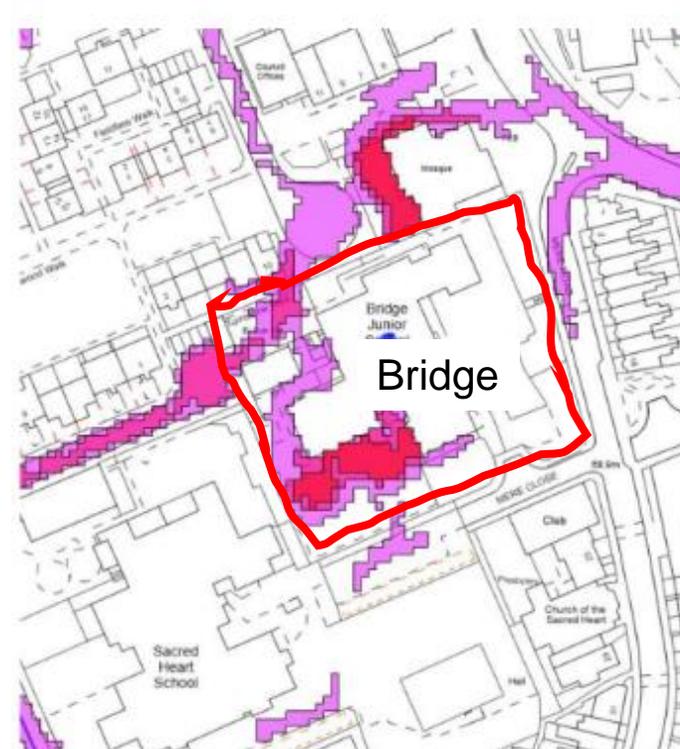
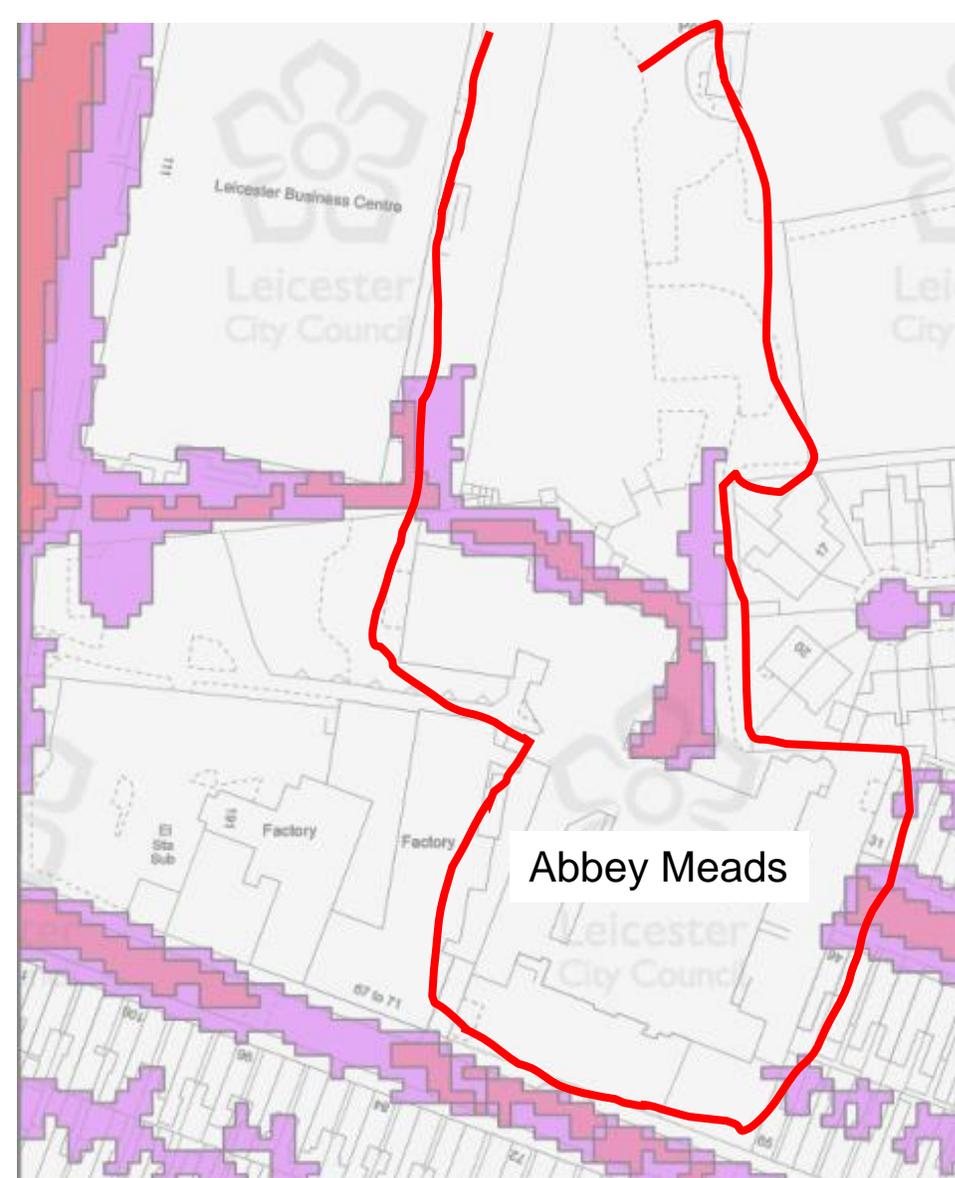
- 3 Schools in Leicester
  - Abbey Mead Primary
  - Bridge Junior
  - Linden Primary
- Educational Sessions
  - 4 face to face sessions
  - 4 teacher led sessions
- Site visit and design of SuDS
- Construction of SuDS
- Partnership – Department of Education (DfE), Trees for Cities, Severn Trent Water, Wildscapes





Grace Walker, landscape design manager at Trees for Cities, said: 'We're delighted to be partnering with Leicester City Council, Department for Education, TMHCC and Seven Trent Water

**Retrofitting innovative suds at 3 city schools plus a programme of education**



### Pluvial risks

Pluvial Flood Risk Category	Annual Probability of Flooding (%)	Colour
Very Low	Less than 0.1%.	Everything outside of colours
Low	1% - 0.1%.	
Medium	3.3% - 1%.	
High	Greater than 3.3%.	

**3 schools identified based on real risks of flooding**



before



after

**Abbey Meads school**



Summer 2023



Rainy day February 2024

Gary Aldred, headteacher at Abbey Mead Primary Academy, said: "The regeneration of the school grounds has not only improved the aesthetics of our outdoor space but provided rich learning opportunities linked to sustainability and ecology.

Pupils have worked with colleagues from Leicester City Council to understand more about sustainable drainage systems and their impact on the environment.



Disconnected downpipes (Bridge)

Creating nature area (Linden)

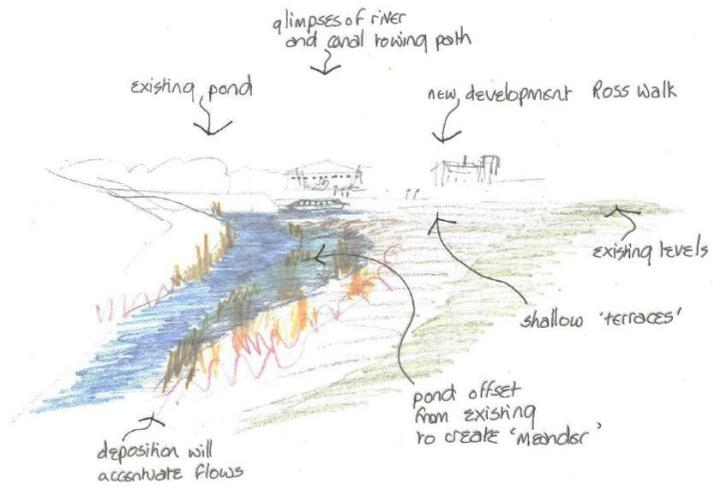
**Examples from the 2 other schools**





### **Local flooding January 2024**

Headteacher and site manager delighted to report no water entering school buildings



Testing the options; initial scheme



- Using parks and open spaces to integrate natural flood management measures to reduce flood risk in urban areas

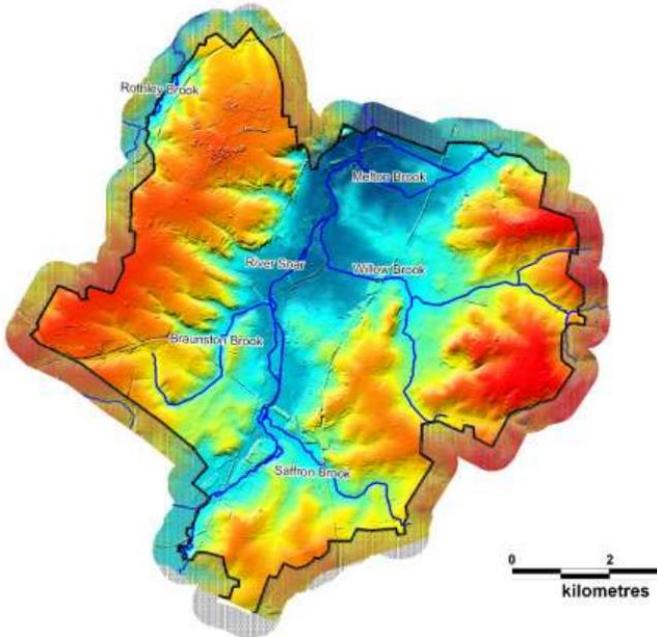
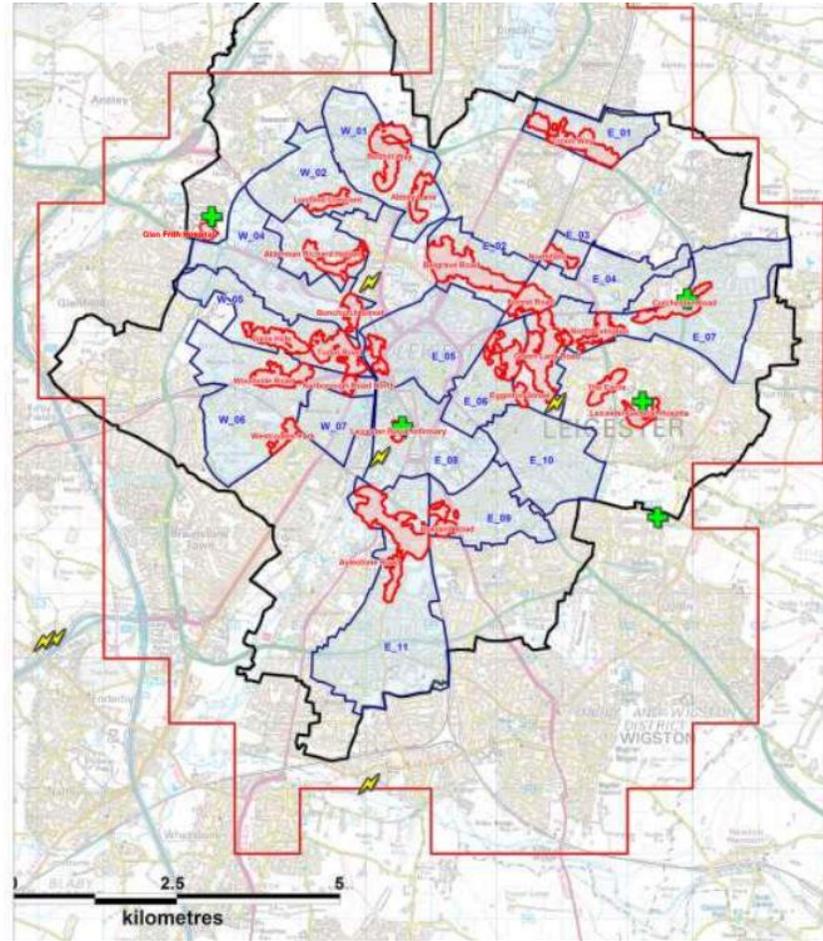
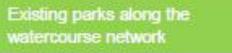


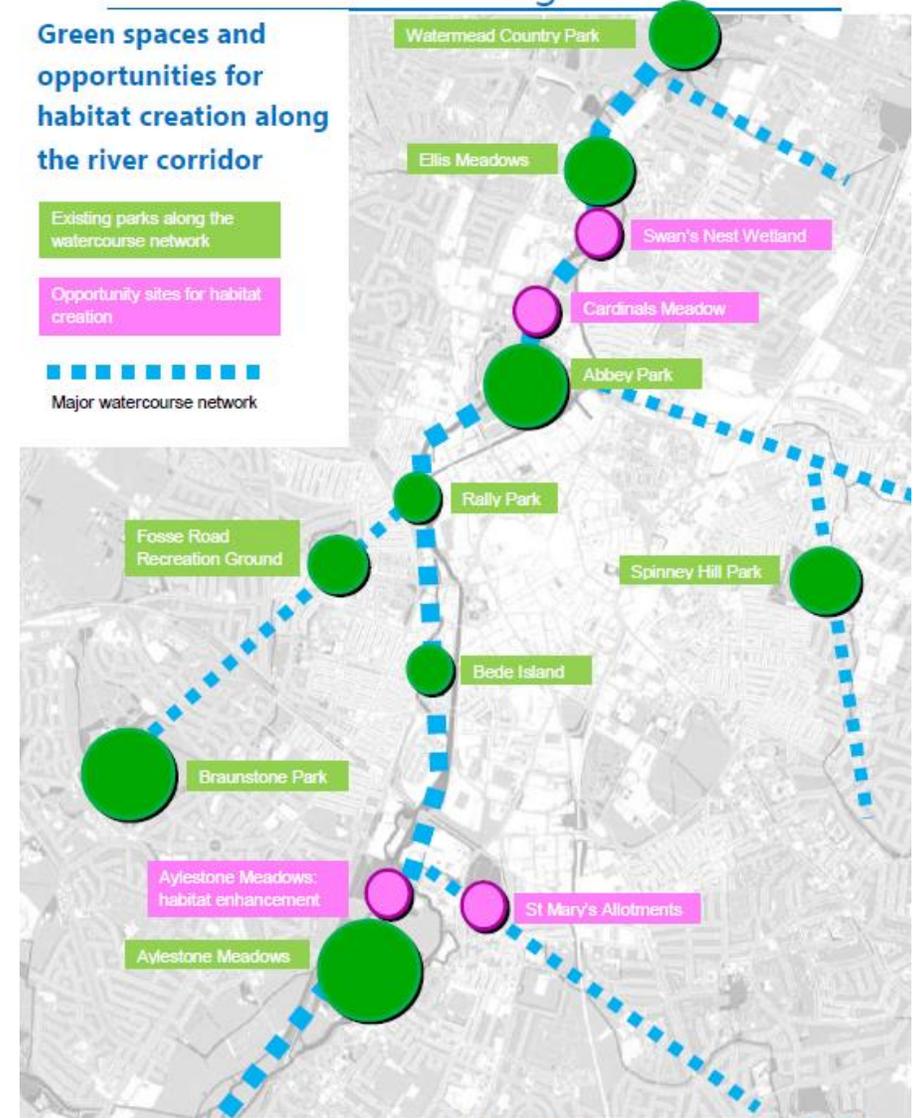
Figure 1-2: Topography of Leicester and Main Watercourses



- |   |   |   |   |
|---|---|---|---|
|  | Critical Drainage Area                    |  | Critical Infrastructure – Major Hospital      |
|  | Local Flood Risk Zone or Flooding Hotspot |  | Critical Infrastructure – National Grid Point |

### Green spaces and opportunities for habitat creation along the river corridor

-  Existing parks along the watercourse network
-  Opportunity sites for habitat creation
-  Major watercourse network



## Mapping the problems and the opportunities

Lower this corner to let flood flow through. Contaminated spoil though!

Place spoil here for additional flood protection

Flood flow conveyance corridor

Cut back brambles and create managed woodland (to allow flow through)

Dig new wetland for clean capping material

- Remove all perimeter chainlink fencing
- Encourage people to access the site
- Footpath connections to the local housing estate
- Maximise habitat creation
- Don't increase the maintenance regime!



*.. from a local resident who wrote into the council on June 16<sup>th</sup> 2017*

'Have just discovered Ellis Meadows ... and wanted to say how wonderful it is. The mass of white daisies were beautiful and the large ponds lovely. I realise from the signboards that it is in essence part of a flood relief scheme along the River Soar, but it really is a lovely natural area'

# Flood Risk Management

Flood alleviation work by the Environment Agency and Leicester City Council is helping to reduce the risk of flooding from the River Soar to homes and businesses in Leicester.

Leicester Flood Risk Management Scheme is an innovative project which reduces flood risk to over 2000 homes and businesses by improving green infrastructure along the river corridor. The project has transformed under-used public open spaces in the city, improving public access and creating new habitat along this important ecological corridor which connects the rural water environments to the north and south of the city. The flood alleviation scheme works by removing barriers to flood conveyance (the movement of flood water) and improving the capacity of the floodplain to store water.

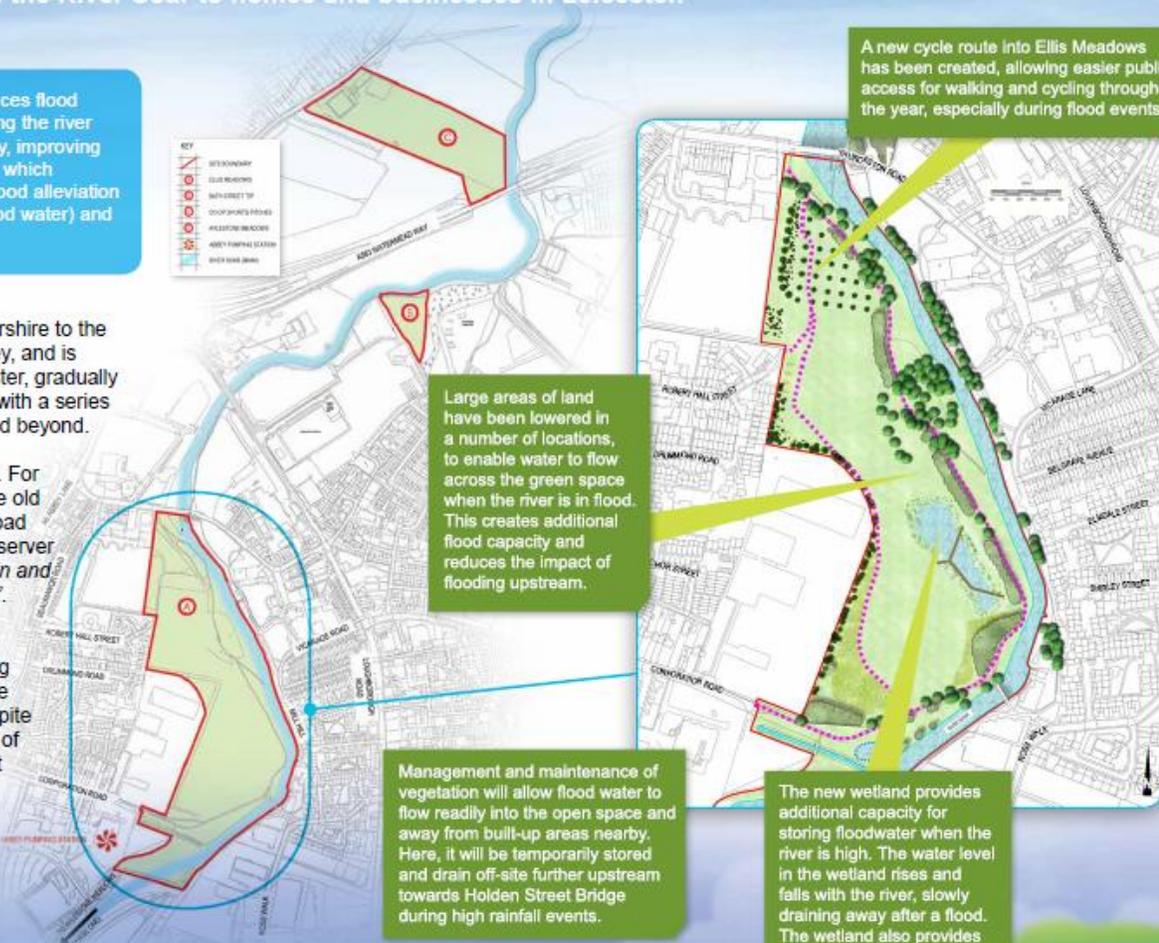
## History of flooding in Leicester

The River Soar is a lowland river which drains most of the land in Leicestershire to the River Trent. The river rises (begins) in south Leicestershire near to Hinckley, and is joined by many small streams as it meanders its way north towards Leicester, gradually increasing in size. The Grand Union Canal weaves in and out of the river, with a series of locks and weirs enabling navigation from the River Trent to Leicester and beyond.



There is a long record of flooding in Leicester. For example, in 1795 a "great flood" destroyed the old North Bridge, which carries Loughborough Road across the river. In 1875, a meteorological observer at Dane Hills noted "thunderstorms, heavy rain and floods in the lower part of town two feet deep".

During the 19th and 20th Centuries extensive engineering works were undertaken to reduce flooding in the city, including widening and deepening of the river in Abbey Park and lengthening of the navigation weirs to reduce flood water levels. However, a study undertaken in 2014 revealed that despite the previous engineering works, as many as 4800 houses were still at risk of flooding from the river. The River Soar Flood Alleviation Scheme is the first step in an extensive programme of work to further protect the city against flooding.



A new cycle route into Ellis Meadows has been created, allowing easier public access for walking and cycling throughout the year, especially during flood events.

Large areas of land have been lowered in a number of locations, to enable water to flow across the green space when the river is in flood. This creates additional flood capacity and reduces the impact of flooding upstream.

Management and maintenance of vegetation will allow flood water to flow readily into the open space and away from built-up areas nearby. Here, it will be temporarily stored and drain off-site further upstream towards Holden Street Bridge during high rainfall events.

The new wetland provides additional capacity for storing floodwater when the river is high. The water level in the wetland rises and falls with the river, slowly draining away after a flood. The wetland also provides valuable habitat for wildlife.



nature takes over (above)

tree inserted into bank and created beach (right)



**Aylestone Leicester**



**It doesn't have to be expensive or complex.. creating scrapes..10 years later multi benefits**



# Natural flood management

*Protecting the people of Leicester*



Wetland creation here seeks to control water flow and reduce flooding by working with nature. It supports and enhances local wildlife value by creating additional habitats to help wildlife in the river, wetlands and flood plain meadows. Slowing water flow and providing temporary storage helps reduce flooding further into the city. There may still be times when access is restricted here as these are flood meadows; take care.



## Flood management

A series of wetlands have been created along the River Soar corridor for water storage, including here at Aylestone Meadows, where new ponds have been designed to hold some water all year. In periods of rainfall these ponds and the flood meadows will store more water temporarily until levels return to normal.



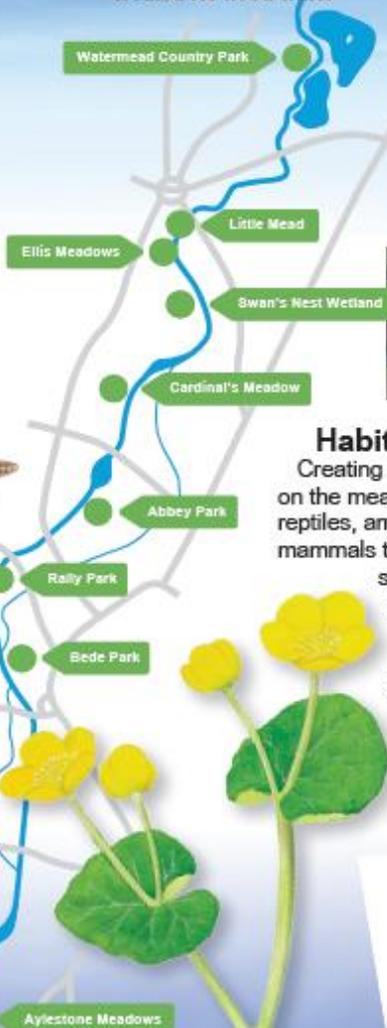
Restoring and creating ponds in the floodplain provide refuges for species that prefer still water. Dragonflies and amphibians (frogs, toads and newts) will breed in ponds. The restored marshy habitat and scrub provide important habitats outside of breeding and a refuge to hibernate.



The map on the right shows the original route of the River Soar before it was straightened to provide space for a municipal tip in 1938. Since then the tip has closed and the area re-naturalised to what is now Tip Top meadow, enhancing local amenity and nature value.



Sites where areas have been created for flood water



Recent works aim to gradually re-create meanders by using 'root wads' and 'beaches' to river bank edges. Material will gradually accumulate around the roots and deflect the water flow towards these beaches, creating curves in the straight section of channel. This will benefit fish, freshwater mussels and invertebrates that need clean well-oxygenated water.



People enjoy using the many paths of the reserve. This picture shows works to strengthen the river bank using coir rolls and a dead tree anchored to the bank, diverting the river away from this bank. The path has also been realigned.

## Habitat improvements

Creating bee banks and grassy mounds on the meadows provides hibernacula for reptiles, amphibians, pollinators and small mammals to hibernate. The meadows also support wildflowers such as harebells and great burnet, and provide a food source for many butterflies, bees and feeding areas for swifts, swallows and bats. Sustainable management, such as grazing and cutting hay, will help manage these areas for wildlife.



## Funding and overall programme

The project forms part of the River Soar and Grand Union Canal Access and Environmental Improvement Programme and is funded by the Leicester and Leicestershire Enterprise Partnership (LLEP). This is a partnership programme between Leicester City Council, the Environment Agency and the Canal and River Trust to provide access and environmental improvements along the canal and river corridor.



Leicester City Council

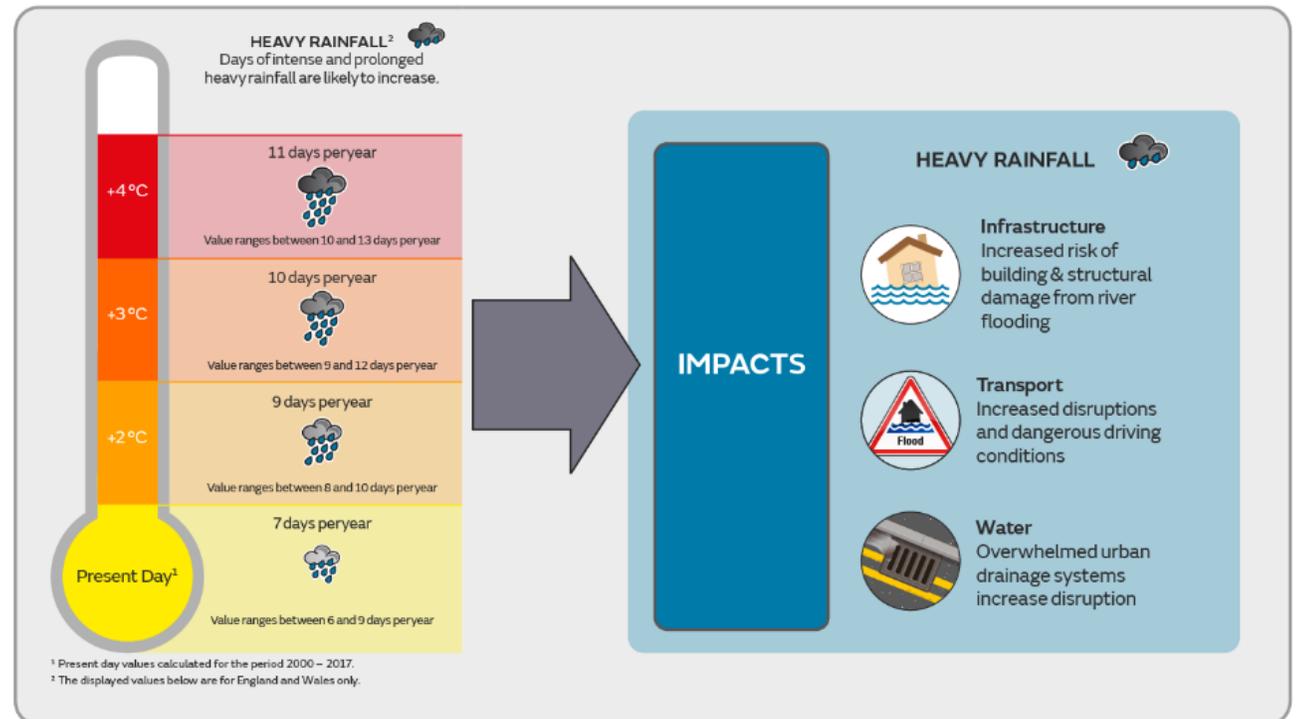


# Conclusion

- Cross-sector and cross-disciplinary work
- Well-designed SuDS and NFM can reduce the flood risk
- Parks and greenspaces
- Planning and decision making
- Climate resilient cities



## Global warming and future high-impact weather in the UK



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*As global temperatures rise, the number of extreme rainfall days is expected to increase.*

# Acknowledgements

SuDS in School project, Leicester 2022-2023:

- Alex Cameron – Project Engineer, Leicester City Council (LCC)
- Lee Jowett – Sustainable Schools manager (previous), LCC
- Grace Walker – Trees for Cities

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**Thank You!**

**Any questions?**