D3.2.: Report Demonstration areas (Revised)

WP 3 , T 3.2

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Technical References

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0 Executive summary

Three demonstration areas, with a buffer that includes nearby schools, have been selected for the implementation phase of Urban GreenUP in Liverpool.

Demonstration areas were selected the following criteria:

- Opportunity to implement NBS in relation to identified issues for the city.
- Opportunity to implement NBS in the time available
- Availability of match funding for NBS interventions
- Engagement and support from landowners, partners and stakeholders
- Established political support
- Opportunity to demonstrate innovation.

The demonstration areas are:

- Baltic Corridor
- Liverpool City Centre Business Improvement Districts
- Jericho Lane and Otterspool

In addition, we have identified schools in a buffer around these areas whom we wish to engage and involve in the delivery of NBS.

Detailed assessment of these areas using the Eklipse Challenge Framework has identified the key issues for NBS to tackle in the demonstration areas. Cities are dynamic places, and Liverpool is no different. The demonstration areas will undergo significant regeneration over the next few years, with multi-billion-pound programmes underway or about to commence.

Within this dynamic environment, NBS can help to tackle some of the issues highlighted in the Diagnosis for the city and detailed for the demonstration areas.

Demonstration areas A and B, Baltic Corridor and City Centre BID, are the historic heart of Liverpool, with streets dating back to the earliest establishment of the city. The area has a rich history, with links to the docks and the world-wide trade that passed through Liverpool. The areas are emerging from decades of decline and are developing quickly with a wide range of businesses moving into the area, new residential development and leisure facilities such as hotels to cater for the increasing number of tourists. A link to the “Fabric District” to the north of the city centre was identified as a strategically important opportunity, with large scale redevelopment and 14,000 new housing units planned, and have been included in our assessment of the City Centre demonstration.

The city centre is a top five tourist destination in England. The main shopping area has footfall of over 60m people each year.

Demonstration Area C, Jericho Lane and Otterspool, is located south of the city centre. The area has less commercial activity and significantly more green infrastructure than the other demonstration areas.

Table 1: Green Infrastructure area in each demonstration area

Demonstration area	Percentage green infrastructure (including water typologies))
Baltic Corridor	7% (17% including the docks)
City Centre BID	5%
Jericho Lane and Otterspool	23%

The areas vary in socio-economic profile as shown in Table 2: Demonstration areas socio-economic profile, data from Liverpool Ward ProfilesTable 2.

Table 2: Demonstration areas socio-economic profile, data from Liverpool Ward Profiles

	Prominent wards in the demonstration areas			
Criteria (sample from City Ward data)	City Centre	Baltic Corridor	Jericho	Jericho
Life expectancy at birth (2013-16)	75.6	77.1	77	82.1
% Working age worklessness (2016)	2.9	12	12	5.7
Average household income (2016) £	25,000	27,000	33,000	42,000
% of children in child poverty (2014)	38	42.5	18.8	7.7
All crime per 1000 persons	258	241	77	37
% of population in most deprived 10% nationally	18	43.7	10	0
Population growth 2005- 2015	80	37	4.6	-3.2

An Initial survey of businesses in the City Centre indicates that there is good support for NBS in the city centre.

In terms of key challenges, issues related to urban heat island, air quality and water management are key concerns. A great deal of work has taken place to identify pluvial and other flood risks to the city.

Star Tools has been used to identify how the planned interventions through Urban GreenUP can help to both reduce flood risk and also reduce impacts of urban heat island.

In the City Centre, the interventions reduce temperature in the 2050 climate change scenario by 1°C. Similarly, water runoff is reduced by approximately 1% assessed against the projected runoff in 2050. The detailed monitoring of interventions will help to develop and localise the Star Tools model.

Air quality is also an issue for the city. However, we have not been able to access the localised data to improve our knowledge for each of the demonstration areas.

Habitat connectivity and biodiversity is limited in the demonstration areas. The Urban GreenUP can provide linkages between existing habitats within and beyond the demonstration areas. We have used the Condatis software to model connectivity of four habitat types.

38 KPIs are currently being considered for the Liverpool demonstration areas. However, these KPIs are based on a more limited set of primary data that will be gathered and analysed in various ways using existing tools (and developments of these tools) and other techniques to provide the KPIs.

An Ex Ante valuation of the planned interventions indicates that from a capital investment of €2.4m, a range of benefits will be provided with an estimated value of €7.9m in terms of wide economic benefit, and €1.3m of GVA. This represents a good investment in the continued, sustainable regeneration of Liverpool and a starting point for wider influence of policy and strategy and contribution to the development of the Urban GreenUP Renaturing Plans and the wider exploitation of NBS internationally.

1 Introduction

The Urban GreenUP Diagnosis provided an ecological and socio-economic assessment of Liverpool. It set out an overview of the city's ecological, economic and social resource base as well as the planning and development context. The Diagnosis also looked at the evidence base for nature based solutions (NBS), opportunities to develop the green infrastructure network and other NBS in the city, and identified gaps and opportunities to use NBS to tackle some of the key issues facing the city.

Our diagnosis of Liverpool's current situation[1] identified a number of issues for which there is good evidence and policy support for NBS. Some of the key city issues identified were:

- Liverpool has seen significant regeneration investment over the past 25 years, with significant EU investment. Liverpool is undergoing a £13bn regeneration-led renaissance with a need to ensure that quality of place is a high priority.
- 14,430 properties are at surface water flood risk from the 1% (1 in 100) event in Liverpool[2]. Of the 33.3km of streams in Liverpool, 29.7km are piped beneath the ground. Many of these culverts (pipes) are over 150 years old and are in poor condition. To combat flood risk, recent EU LIFE IP research has found that Liverpool should be a focal area for low density urban tree planting[3].
- Liverpool has a relatively young population. The 2014-based projections by ONS estimate that Liverpool's total population will increase by 5% by 2027, but the city's over 65 years population was projected to increase by 17%.
- The whole of Liverpool was declared an Air Quality Management Area (AQMA) in May 2008. Currently, Liverpool has exceeded statutory oxides of nitrogen emission targets[4]. Concentrations of sulphur dioxide (SO_2), particles (PM_{10}), ozone (O_3) and other measures remain largely undisclosed[5][6]. High concentrations of these substances and others represent pollution and a risk to health[7].
- The severity of Liverpool's health deprivation is reflected in the life expectancies for its population. Life expectancy for males is 76.2 years, and 80.5 years for females, which are below the national average. Despite significant regeneration in Liverpool, economic deprivation remains high.
- There are indications of a growing issue with childhood obesity, as 23.8% of children in Year 6 (8-9-year olds) are classified as obese, worse than the average for England.
- Common mental health problems are estimated to affect a quarter of Liverpool's population at any one time.

[1] Liverpool Diagnosis submitted as part of the Urban GreenUP programme, Deliverable 3.1
[2] Liverpool City Council (2018) Draft: Local Flood Risk Management Strategy. Unpublished Planning Policy Paper. 1 – 87.
[3] JBA (2017) Merseyside Strategic NFM Targeting Maps: User Guide. The Rivers Trust, Natural Course (EU LIFE IP) and JBA. Unpublished Technical Paper. Skipton:JBA. 1 – 21.
[4] http://liverpool.gov.uk/council/strategies-plans-and-policies/environment-and-planning/air-quality/
[5] http://liverpool.gov.uk/business/environmental-health/air-quality/ ,
[6] http://liverpool.gov.uk/pests-pollution-and-food-hygiene/pollution/air-pollution/
[7] https://uk-air.defra.gov.uk/air-pollution/uk-eu-limits

- The city has areas of high biodiversity value, with 25 Sites of Nature Conservation Value, four Local Nature Reserves, one Site of Special Scientific Interest, and the Mersey estuary, which also has the highest level of designation as it is both a Special Protection Area and a Ramsar site. Despite this there are few formal data sets or historic habitat records, and green space provision in the urban city centre is considered to be fragmented with correspondingly low biodiversity connectivity.
- In addition, the Diagnosis highlighted a number of challenges that included: reduced funding for both local government and the natural environment; the issues subsequently created for NBS delivery and management; the need to improve involvement of local communities in their natural environment and a need to have better data for issues such as climate change resilience.

We have identified demonstration areas in the city where we plan to implement NBS; using and adapting best practice, sharing our ideas with other lead and follower cities in the Urban GreenUP Partnership, monitoring impacts and developing NBS products that can be promoted globally.

In our Diagnosis we used the ten Eklipse Challenges as an organising framework. We linked this framework to the City's Local Plan Vision for Green Infrastructure.

Table 3: Relationship between Eklipse Framework and Liverpool City Council's Vision for Green Infrastructure

Liverpool City Council Vision for Green Infrastructure (taken from the Local Plan)	Themes	Eklipse Framework Challenges
To protect and enhance Liverpool's green infrastructure to ensure more attractive and cleaner residential neighbourhoods; sustain and promote biodiversity; mitigate against and adapt to climate change including contributing to flood risk management; and to provide greater opportunities for sport and recreation and growing food locally to encourage better health and wellbeing.	Sustainable City	Urban regeneration, green space management, promotion of economic opportunities and green jobs, participatory planning and governance
	Cool City	Water management, climate adaptation and mitigation
	Healthy city	Air quality, public health and wellbeing, social justice and social cohesion
	Biodiverse city	More, bigger, better managed and well-connected habitats, enhancing ecological networks

In this report we:

- Identify and describe the demonstration areas;
- Highlight the key issues in these areas;
- Propose a series of interventions for each demonstration area to tackle specific issues; and
- Describe the monitoring framework for the programme.

Our discussion of the current baseline situation is focused on green infrastructure, as this has not only been the most prominent type of NBS employed in the city to date, but also the most effective way to tackle the key challenges identified in the diagnosis report. As described in the Diagnosis, our selection of the demonstration areas has been influenced by a variety of factors and a pragmatic selection of demonstration sites has been made based on the following criteria:

- Opportunity to implement NBS in relation to identified issues for the city
- Opportunity to implement NBS in the time available
- Availability of match funding for NBS interventions
- Engagement and support from landowners, partners and stakeholders
- Established political support
- Opportunity to demonstrate innovation

The demonstration areas are:

- Baltic Corridor
- Liverpool City Centre Business Improvement Districts
- Jericho Lane

In addition, we have identified schools in a buffer around these areas whom we wish to engage and involve in the delivery of NBS.

2 Description of the demonstration areas

The demonstration areas have been selected to deliver NBS for identified issues in Liverpool. The following sections provide a brief description of the historical development and the current plans for the development for each of the demonstration areas. Where available we have highlighted any specific plans to incorporate green infrastructure into the current plans for development in the three demonstration areas.

As described in the Liverpool Diagnosis for Urban GreenUP, there is strong policy support for NBS, especially using green infrastructure for tackling the city's challenges, both in national policy and at city level through the National Policy Planning Framework and the Liverpool Local Plan. Our description of the demonstration areas evaluates whether this policy framework is translated to the local level.

2.1 Sub-Demo A - The Baltic Corridor

The Baltic Corridor is south of Liverpool City Centre and connected to the Business Improvement District demonstration area by Bold Street. The area sits alongside and between several key investment zones, with over £3bn of investment on site or in the pipeline for delivery.

Historically, this was an area of warehousing and primary industry for the docks of Liverpool. As the docks declined, so too did the businesses associated with them, leading to neglect and decline of the area over several decades.

It is now emerging as an eclectic mix of independent shops and businesses, in particular creative industries. There is an increase in residential development and, more recently, of hotels in the area.

The Baltic Triangle forms part of this corridor.

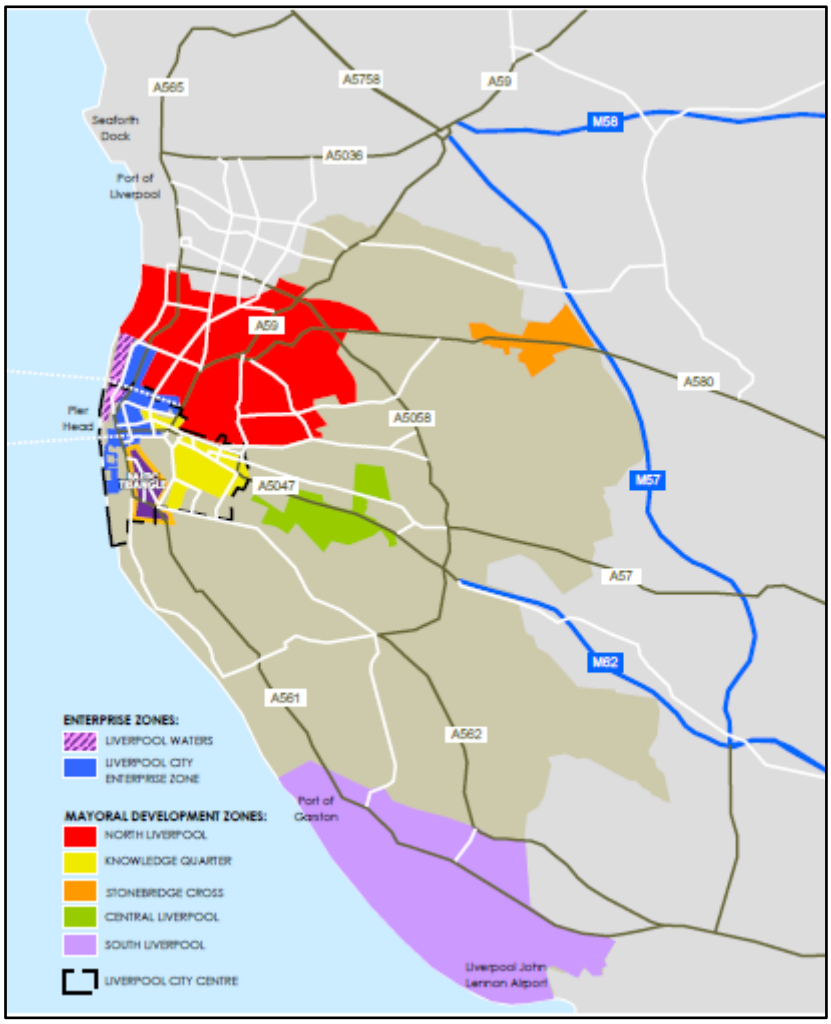


Figure 1: Baltic Triangle and nearby Enterprise and Development Zones

In September 2017, a Strategic Development Framework for the Baltic Triangle was published (draft) in response to the recent acceleration of regeneration in the area. The Framework looks to set a long-term vision for the area, to accommodate and influence new development whilst reassuring and safeguarding the existing businesses and residents[8].

Whilst there is no mention of green infrastructure or other NBS, there is recognition in the document of the lack of green spaces and the poor quality of most of them. Many have been

[8] http://regeneratingliverpool.com/project/baltic-triangle/

created from housing clearances and have lacked investment in recent times. The Framework calls for an improvement in green spaces:

"*With the increasing spread of residential and student accommodation into the area, more attention is needed to identify public greenspace of value that complements surrounding buildings and uses, and is of greater quality than at present*."

The Baltic Corridor has been identified in the Green and Open Space Review[9] as an area where there are currently issues of poor connectivity for pedestrians and cyclists between the waterfront and the city centre and where there is a degraded environment.

As one of the fastest growing locations in the city there are potential conflicts between communities engaged in significant economic regeneration activity, new cultural businesses, new student accommodation and an established local residential population including a primary school and church. The area has a poor perception by residents and visitors of connectivity to surrounding areas.

Figure 2: Location of the adjoining interventions at Baltic and Liverpool BIDs

[9] http://liverpool.gov.uk/mayor/mayoral-commissions/strategic-green-and-open-spaces-review-board/

The Baltic Corridor covers an area of 74.2ha and a population of 3,521.

Based on the city-wide green infrastructure mapping we are able to provide accurate information on the typology of green infrastructure in each of the demonstration areas.

Approximately 73% of the Baltic Corridor is built up. The docks make up 10% of the green infrastructure of the area. Private gardens, institutional and amenity green spaces make up the majority of the 17% of the remaining green infrastructure. There are few street trees, little woodland and no above surface water courses.

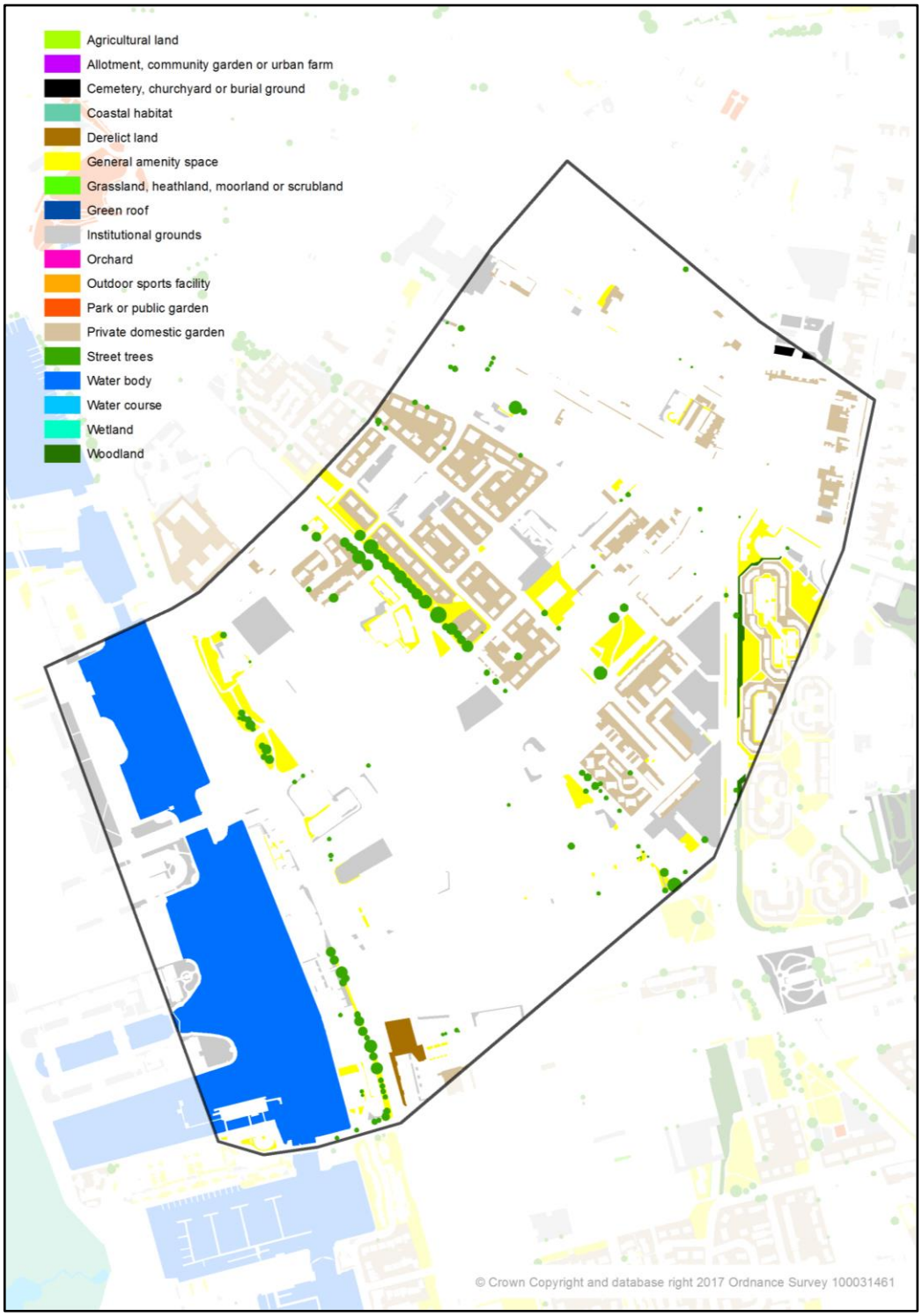


Figure 3: Green Infrastructure typology in Baltic Corridor

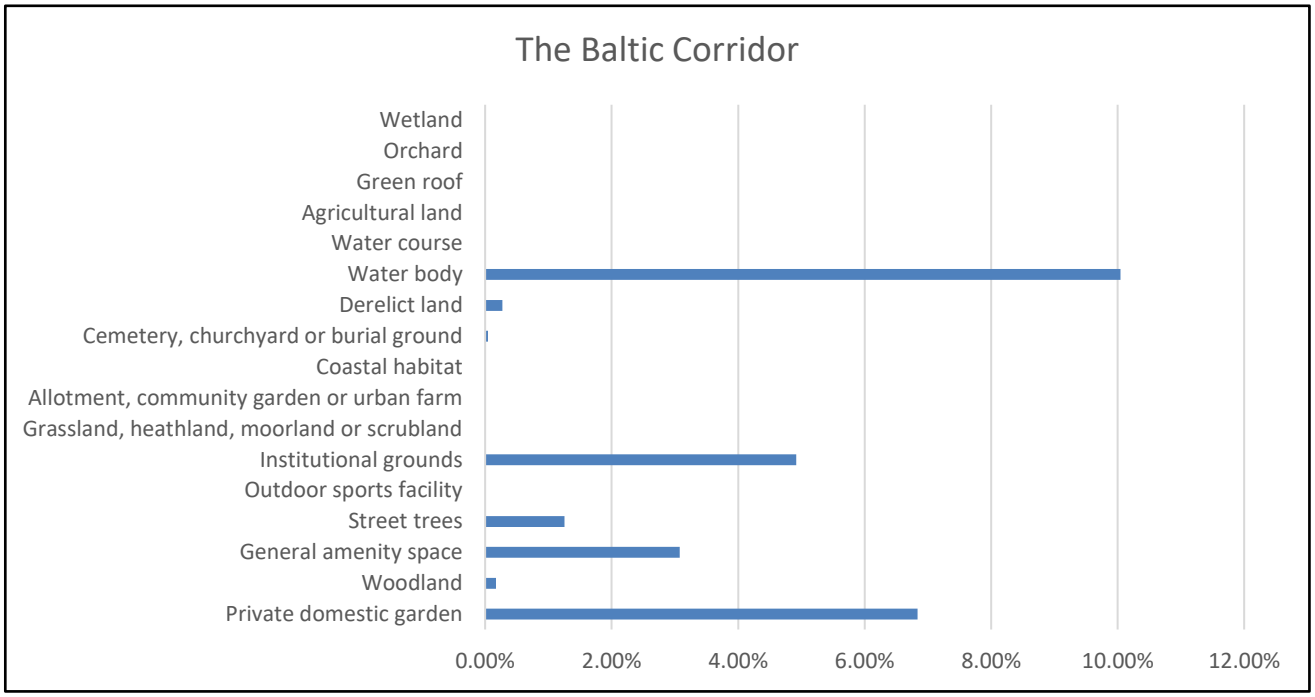


Figure 4: Typology for Baltic Corridor

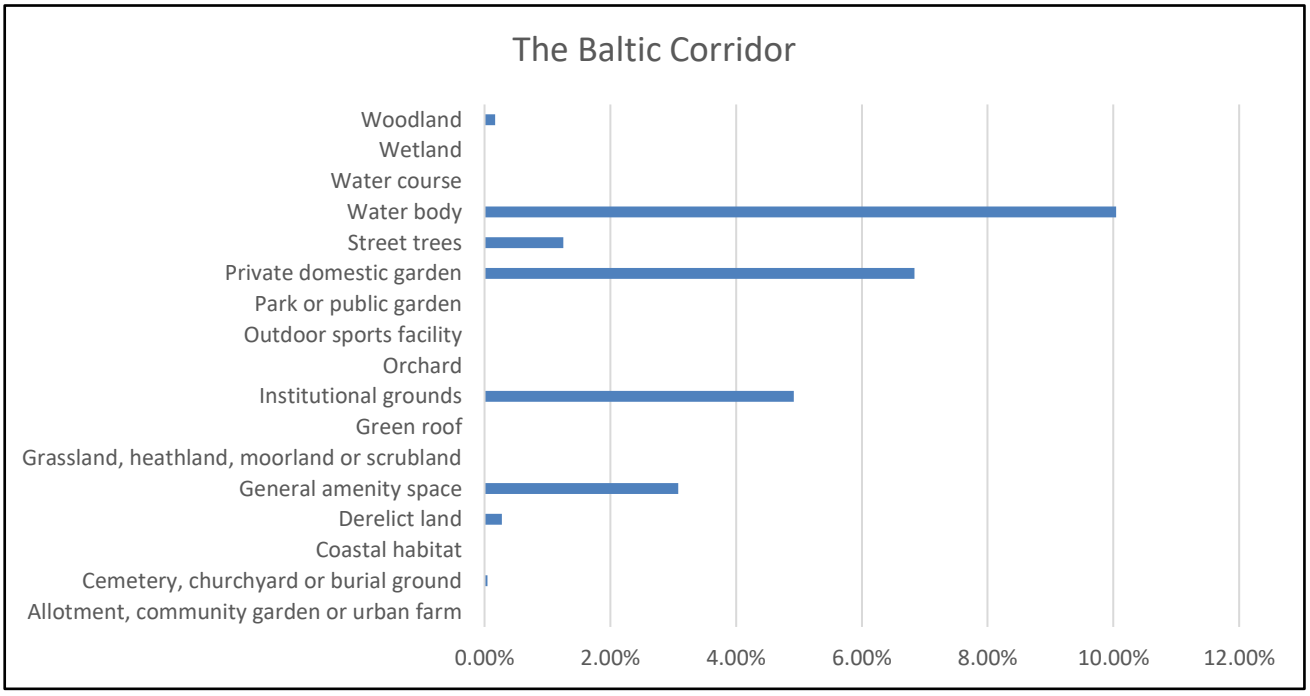


Figure 5: Green Infrastructure Typology for Baltic Corridor

As part of a University of Liverpool MSc Environmental Planning and Management project in 2016/17, a team of students developed a sustainability appraisal for green infrastructure interventions in this part of the city in preparation for the Urban GreenUP programme.

A SWOT analysis of the area was carried out as part of the appraisal. An extract of this analysis is shown below. The full report by the students is provided as one of the accompanying documents to this report.

Table 4: Baltic Corridor: SWOT Analysis

Strengths	Weaknesses
○ Cultural hub ○ Attractive for new businesses ○ Within close proximity to other major landmarks ○ Historic buildings ○ Some areas of green space in the Baltic Triangle	○ Poor connectivity between Bold Street and the Baltic Triangle ○ Poor air quality ○ Flood risk to Bold Street and the Baltic Triangle ○ Lack of dwell time in Bold Street and the Baltic Triangle
Opportunities	**Threats**
○ Multiple brownfield development sites ○ Creative nature of district provides scope for innovative GI ○ Strong identity could be created improving competitiveness of the district ○ Space to implement cycle and walking Network	○ Businesses are not consistent to maintain GI ○ Gentrification displacing communities ○ Meeting the needs of a diverse range of interests

Several issues identified by the Liverpool Diagnosis (D3.1) are also reflected in this SWOT analysis. For example, the poor air quality and risk of flooding together with the need to provide ways to improve the experience of the area so that people stay longer in the area are identified under weaknesses. The value of green infrastructure as a way to improve the image of the area is highlighted under listed opportunities, as is the need to increase and improve active travel in the Baltic.

2.2 Sub-Demo B - City Centre Business Improvement Districts

The City Centre demonstration area is focussed on the main business and commercial areas of the city and the city region. The demonstration area is focussed on the historic heart of the city, central to its development over 800 years since the city was granted a royal charter by King John in 1207. The original grid iron of seven streets, Castle Street, Chapel Street, Dale Street, High Street, Old Hall Street, Tithebarn Street and Water Street, that were the basis for the mediaeval development of the city are part of this demonstration area.

The city developed slowly for several centuries, the main port at the time being that of Chester.

In the 16th Century, as the port at Chester (at the time the main port on the north west coast of England) became silted and less accessible, Liverpool developed and although the 9m tidal reach meant that expensive docks rather than riverside wharfs were needed to accommodate larger ships, civil engineer Thomas Steer's conversion of a muddy tidal creek (the original 'Liver

Pool') to the modern world's first enclosed stone dock in 1715 began the port's exponential growth into a latter-day trading city-state, on a scale to eclipse any in Europe[10].

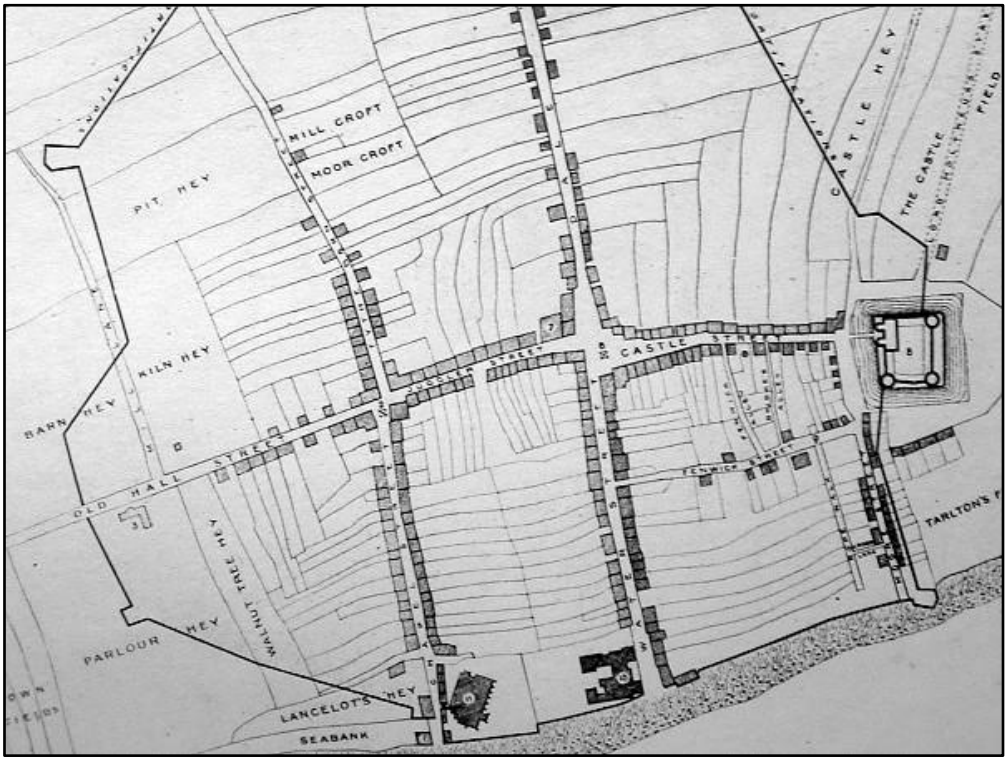


Figure 6: W. Ferguson Irvine's conjectural plan of Liverpool's original 7 streets

As described in the Diagnosis, de-industrialisation of the UK in the 1970s and 80s, resulted in a dramatic decline in the population of the city and a major reduction in the services and industry associated with the docks in Liverpool.

An initial, slow upward cycle in the fortunes of the city began in the late 1980s and continues to the present day. The city's business and commercial districts, centred on the original city footprint, provides a focus for the regeneration of the city.

Today, the Commercial and Retail Business Improvement Districts are managed by the Liverpool BID Company.

The business community in Liverpool City Centre is of significant importance to city's regeneration. The city is in the top five visitor destinations in the UK, generating £3.5bn for the local economy.

The Commercial BID currently has over 550 businesses, employing more than 60,000 people.

[10] Sykes, O., et al. A City Profile of Liverpool. J. Cities (2013), http://dx.doi.org/10.1016/j.cities.2013.03.013

Liverpool Central BID covers the main shopping area of central Liverpool. It is one of the UK's leading retail areas, with footfall of over 60 million people per year.

Maintaining and enhancing the City Centre experience, attracting more visits and increasing spend is crucial for the long-term growth and development of retail centres. Making best use of all the available assets is essential. These provide the draw and the experience, influencing return trips and the amount of money spent.

In recent years the local private businesses have come together with The Mersey Forest to work as a formal partnership to exchange knowledge and to improve the local city centre environment[11]. The BID identified the need for improved city centre green infrastructure which they believe will: improve their city centre economic resilience; improve liveability and quality of experience; improve air quality; reduce impacts of climate change and introduce greater biodiversity. The BID has included green infrastructure improvements in their latest BID Business Plan, and is promoting business involvement in the Urban GreenUP project. The BID leadership are involved in the network of northern BIDs, stretching across the M62 corridor. This network provides an opportunity to promote the type of NBS interventions across many major towns and cities. The delivery of NBS in this BID will be an important case study that will enable the City Centre BID to promote NBS to peers.

The city centre of Liverpool is one of the worst resourced neighbourhoods of the city for green space. The city centre is constrained by its density and the limited availability for green space development. Therefore, although the area is the economic hub of the city it lacks a level of quality and functionality to its environment.

In developing the City Diagnosis for Urban GreenUP, the importance of the area to the east of the BIDs was identified. This appears to be the latest area in the city to regenerate rapidly. Over 14,000 housing units are planned. Making links for active travel and using green infrastructure to link the city centre to this new population is an opportunity for Urban GreenUP to explore. This additional area has been added to the demonstration area baseline.

In addition, Liverpool BID are keen to show how improved green infrastructure can help businesses growth.

A survey of businesses carried out in the development phase of Urban GreenUP showed that:

- Over nine in ten businesses consulted (92%) were of the opinion that a green infrastructure would enhance the BID districts.
- Almost seven in ten businesses (69%) stated that the greening of the two BID districts would be of benefit to their business.
- When asked how the creation of a green infrastructure would be of benefit to their business, the key unprompted reasons given were: nicer environment/nicer place to work in (28%), increased spend levels (19%), 'holistic' reasons including health and wellbeing, feel good factor, ambience (19%), increased footfall (17%) and brightening up the area (17%).

[11] http://www.liverpoolbidcompany.com/

- When prompted with a number of key benefits, the top three ranked potential outcomes were:
    - Increased footfall
    - Attracting new business
    - Increased spend levels
- Over four in every five (83%) were of the opinion that their staff would welcome the greening of the BID areas.
- Over four in every five (81%) were of the opinion that their customers would welcome the greening of the BID areas.
- Three in every four (75%) expressed interest in involvement in a task group to enable the planning of the greening of the BID areas.

Through the development of the Liverpool Diagnosis we also found that the district to the east of the city, known as the Fabric District due to its historical link to cloth sales and clothing manufacture, is undergoing significant redevelopment. Over 14,000 new housing units are anticipated. Creating a link to the city centre, to both promote active travel and also blend green infrastructure improvements for aesthetic and habitat connectivity reasons is seen as an excellent opportunity for Urban GreenUP.

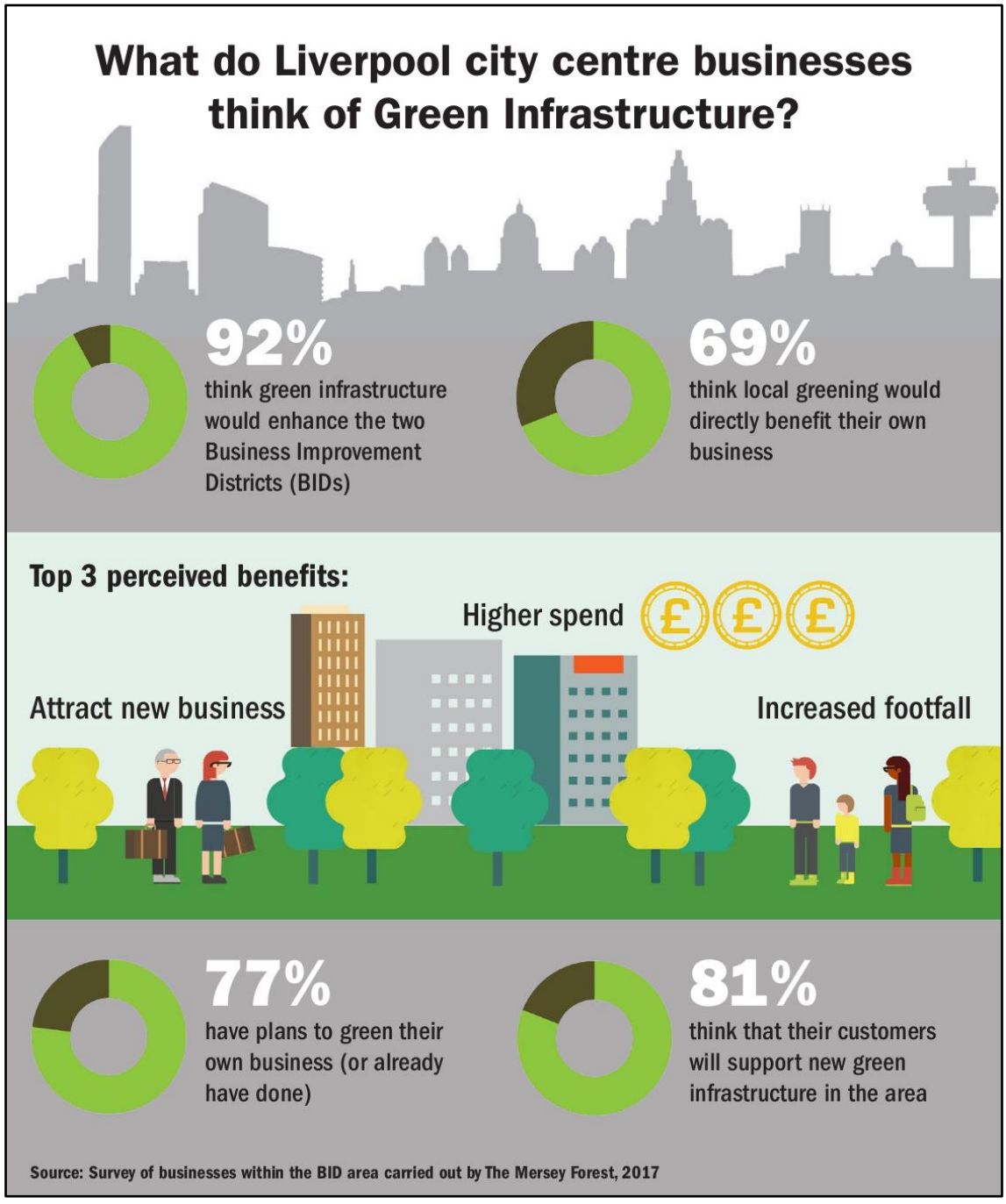


Figure 7: Feedback from 80 BID Businesses on the value and role of green infrastructure.

An audit of the area showed that Liverpool BIDs have low levels of green infrastructure.

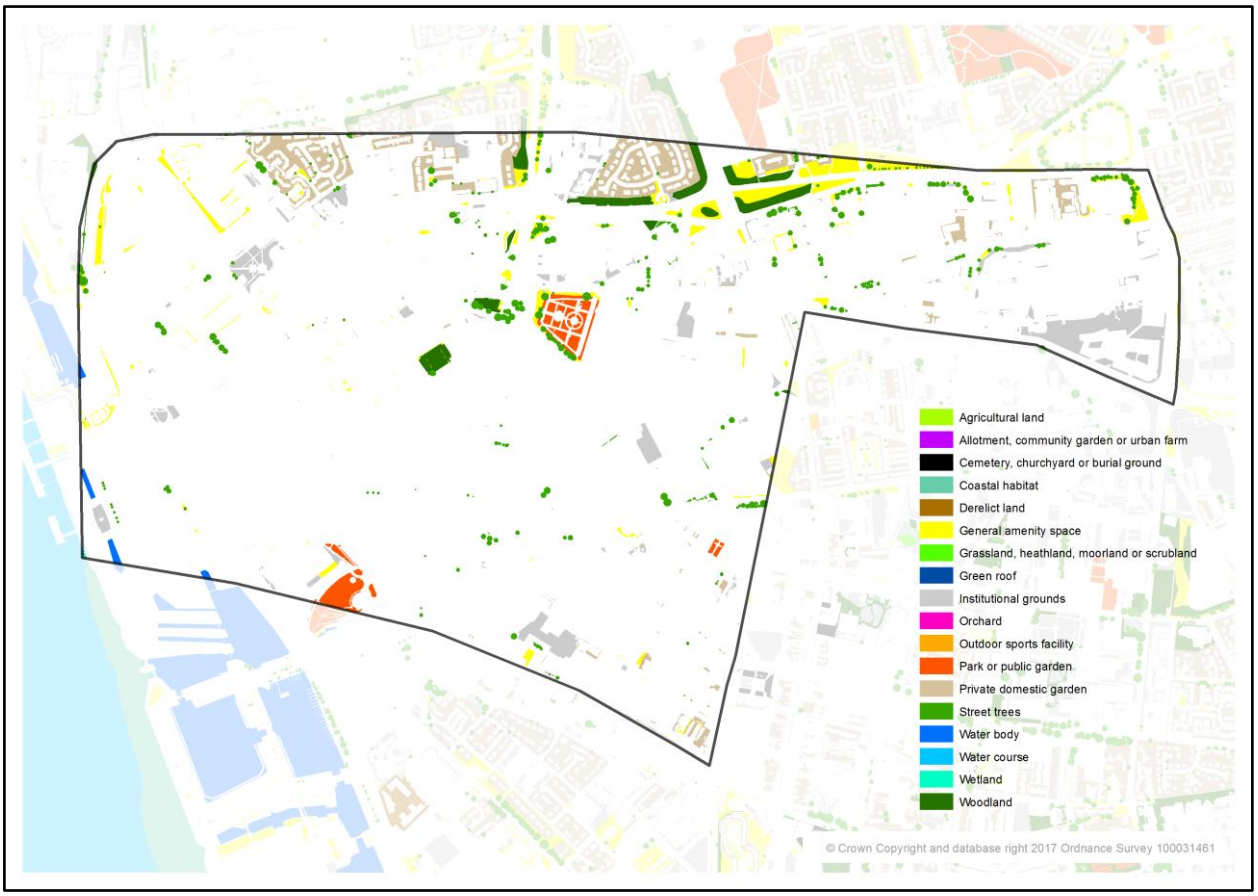


Figure 8: City Centre Green Infrastructure Typology

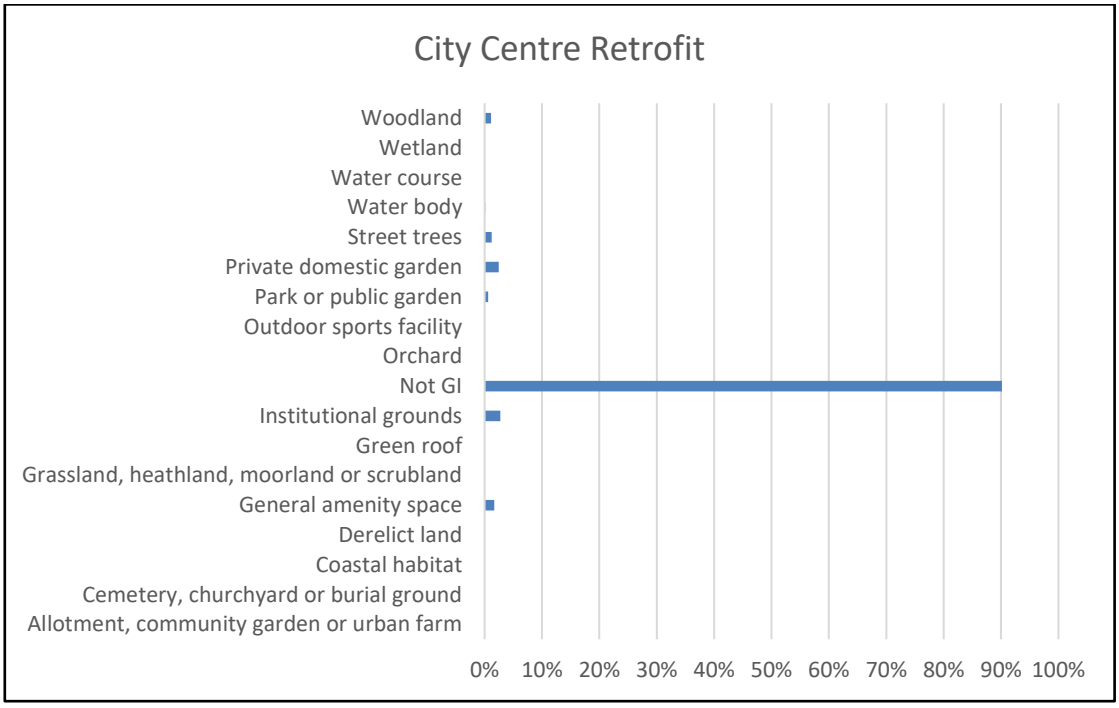


Figure 9: Typology for the City Centre

If we exclude the typology "not GI", we can see the relative amounts of green infrastructure in the area.

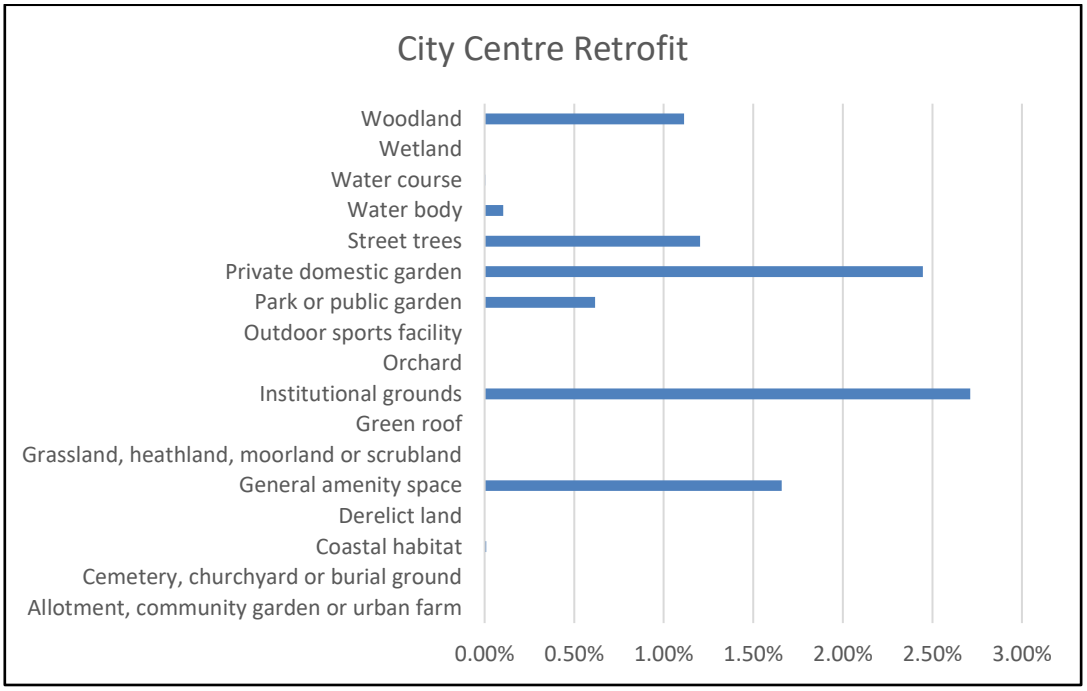


Figure 10: Green Infrastructure typologies in Liverpool City Centres

The City Centre Bid and Fabric District areas cover an area of 203ha with a population of 11,400.

The key green infrastructure components are institutional grounds, private domestic gardens and general amenity space with lesser amounts of woodland, street trees and water. However, despite this mix of green infrastructure the overall, the amount of green infrastructure is very low at 5%.

A previous study looking only at the BID areas and not the wider demonstration area that is proposed for Urban GreenUP compared the amount of green infrastructure in the two BID areas, with that for the wider Liverpool City Centre and additionally with the Victoria BID in London. The City Centre BID and the commercial district both had very low levels of green infrastructure compared with the general city centre. This scarcity of green infrastructure is further emphasised when the city centre green infrastructure is compared with that in the London Victoria BID which has twice the green infrastructure than Liverpool city centre; possibly because Victoria was the first BID to undertake a green infrastructure audit[12]. The Liverpool BIDs have very low levels of green infrastructure.

[12] http://www.victoriabid.co.uk/work/green-infrastructure-gi-research/

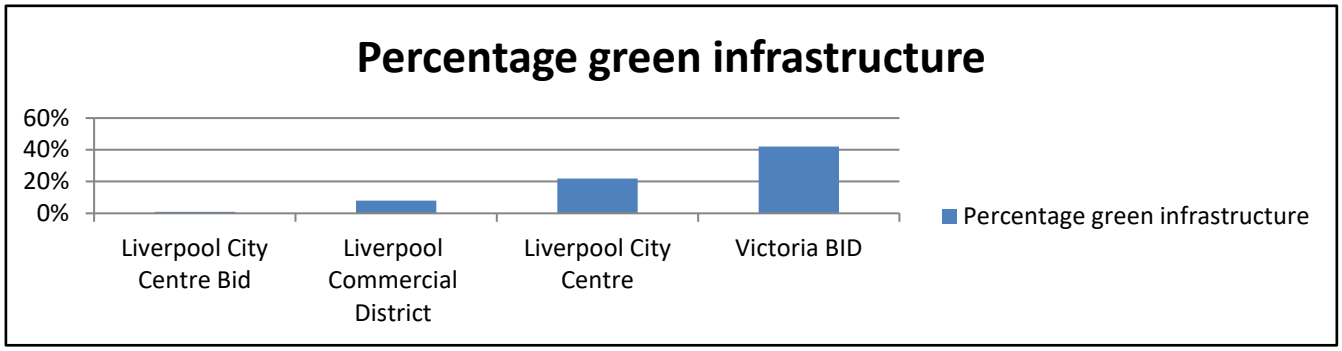


Figure 11: Green Infrastructure in the BIDs

In advance of the Urban GreenUP programme a document of proposals for interventions was produced by The Mersey Forest and Total Environment. (See accompanying document). This provides an overview and project examples that have helped to inform and direct the delivery of the Urban GreenUP interventions.

The document highlights that need for long term planning for interventions as well as the need to link up with other interventions happening in the area such as the lighting strategy being developed for the city.

2.3 Sub-Demo C - Jericho Lane/Otterspool SUDS

This suburban site is already perceived as a green area with extensive biodiversity but it has drainage issues and associated pedestrian connectivity issues and some local air quality concerns.

The proposed Jericho Lane/Otterspool corridor links three key city greenspaces: Princes Park, Sefton Park and Otterspool Promenade. In addition to linking the three sites to provide improved pedestrian connectivity between them, there are a number of localised drainage issues in Princes Park and an opportunity to create a blue (water) corridor within a green corridor by linking work on water quality and water drainage from Princes Park, through Sefton Park to Otterspool Promenade. Opportunity exists along this corridor to additionally address lake overflow issues in Sefton Park and historic drainage problems close to Otterspool where the existing drainage infrastructure is reaching the end of its life. Proposals at Otterspool are focussed on designing and trialling a natural drainage solution with waters being opened up in a 'parkland' setting as a SUD project. There are also similar drainage issues nearby in Princes Park and there is an opportunity to create a blue corridor within a green corridor by linking work on water quality and water drainage from Princes Park, through Sefton Park to Otterspool Promenade; and in doing so to also seek to address issues of pedestrian connectivity between these sites. This would be contrasted with both a previously implemented SUD project which has proved very successful and with a similar one that has not been as successful to learn and share lessons. To ensure that the areas water systems are functional a process of de-culverting, where feasible, will be considered to reinstate the areas waterways and provide additional areas of open water. Although the area has good

biodiversity there will be the opportunity at the SUDS site to provide public access to the open water site and to enhance existing biodiversity through appropriate aquatic planting.

Pedestrian linkages between the three sites would benefit from a number of the city's best-used linear corridors. However, along its route are several recent housing developments and amenity green spaces/sports pitches, which are of varying quality. To address this, a series of interventions along the transport routes linking into the areas green spaces would provide a solution to this connectivity challenge. For example, working with colleagues in the city's Highways Department it is proposed to improve the Jericho Lane/Aigburth Road junction road through increased accessible paving and a redesigned layout to facilitate movement, especially for young and older people. Additional urban greening in the form of buffer planting could be used to provide further moderation of the areas emissions. To ensure that the areas water systems are functional a process of de-culverting is proposed to reinstate the areas waterways by SUDS and innovative monitoring of water management.

Figure 12: Location of Jericho Lane demonstration area

Figure 13: Images of Jericho Lane intervention area

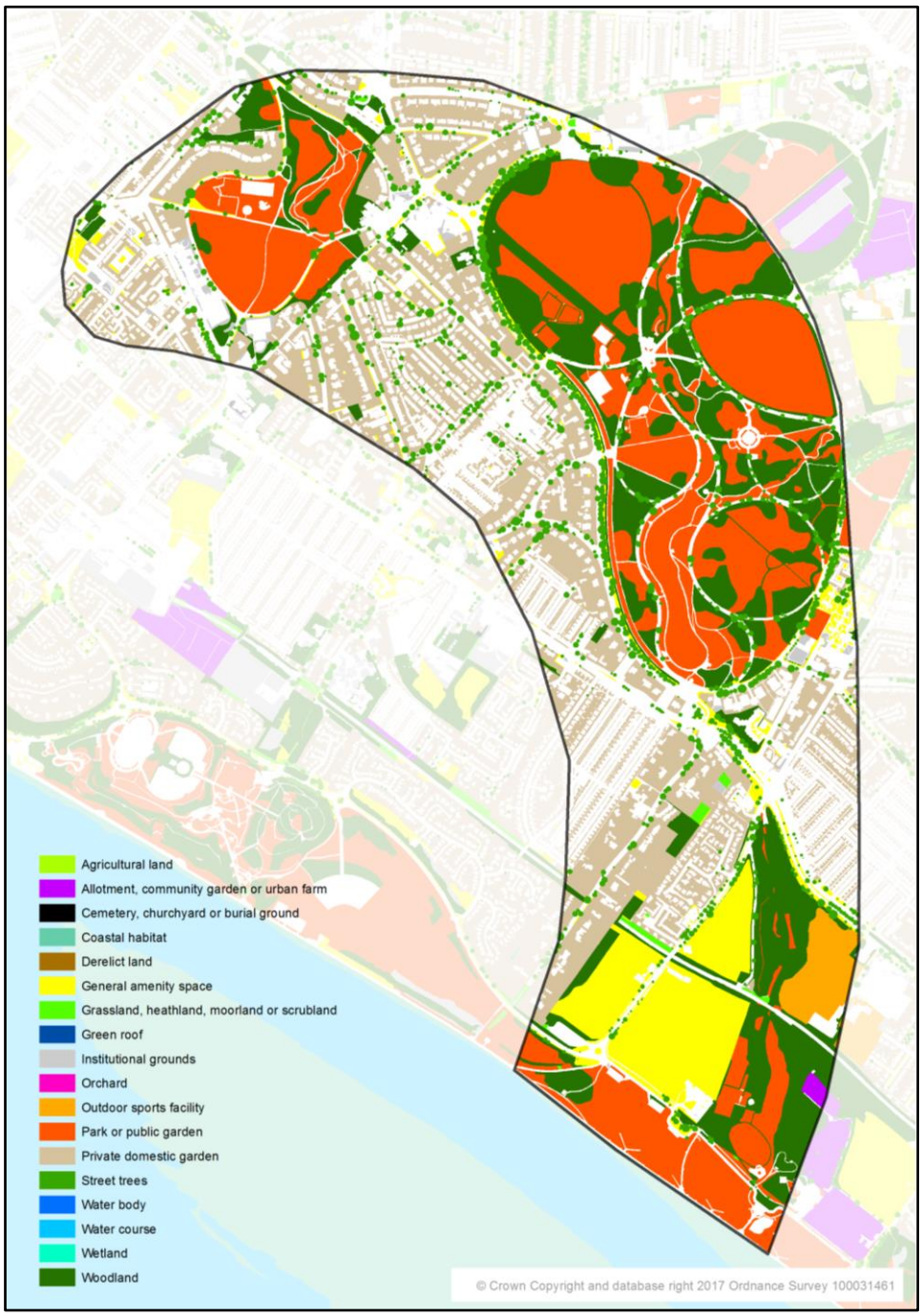


Figure 14: Jericho Lane Green Infrastructure Typology

The Jericho Lane demonstration area covers 300ha and has a population of 11,000.

This area has significantly more green infrastructure than the other two demonstration areas. There is almost as much parkland as there is built up area (Not GI), with 23% and 27% of land cover respectively. This is the only demonstration area with a significant area of woodland. As in other areas, private gardens are an important element of green infrastructure, at nearly 20% of the area. Overall 77% of the area is green infrastructure.

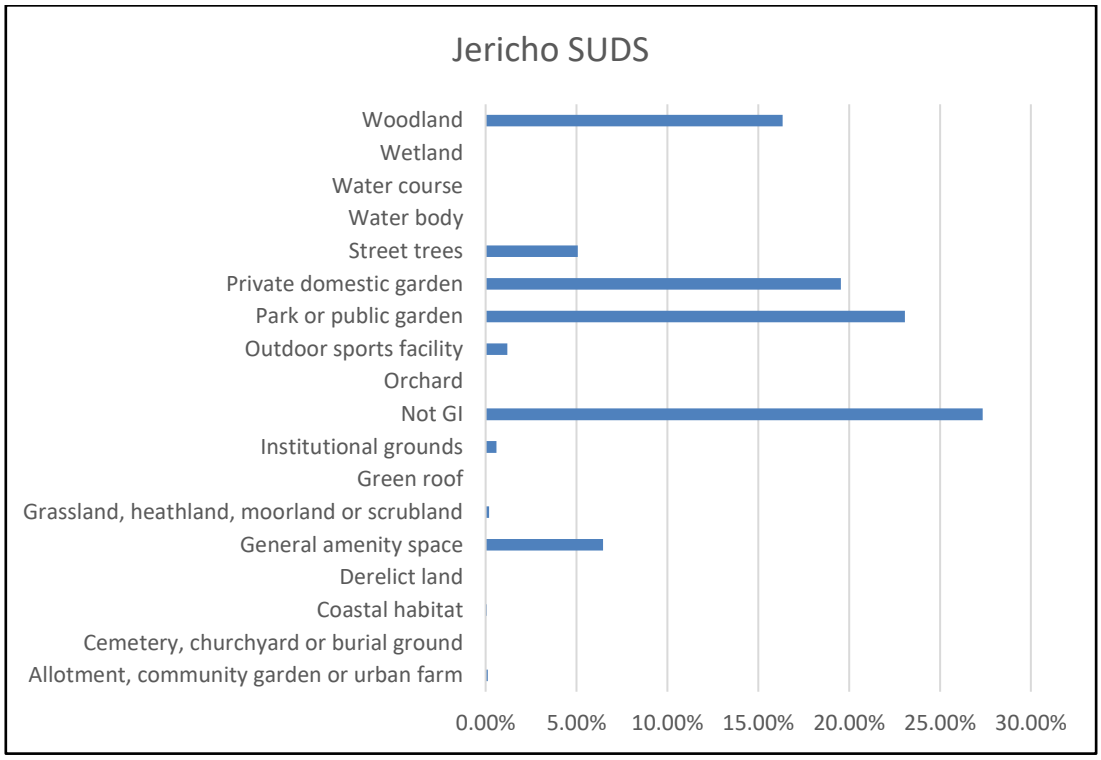


Figure 15: Typology for Jericho Lane

The Figure 16 shows the percentage of green infrastructure for each typology when the non-green infrastructure element, the built up areas etc. are excluded from the data.

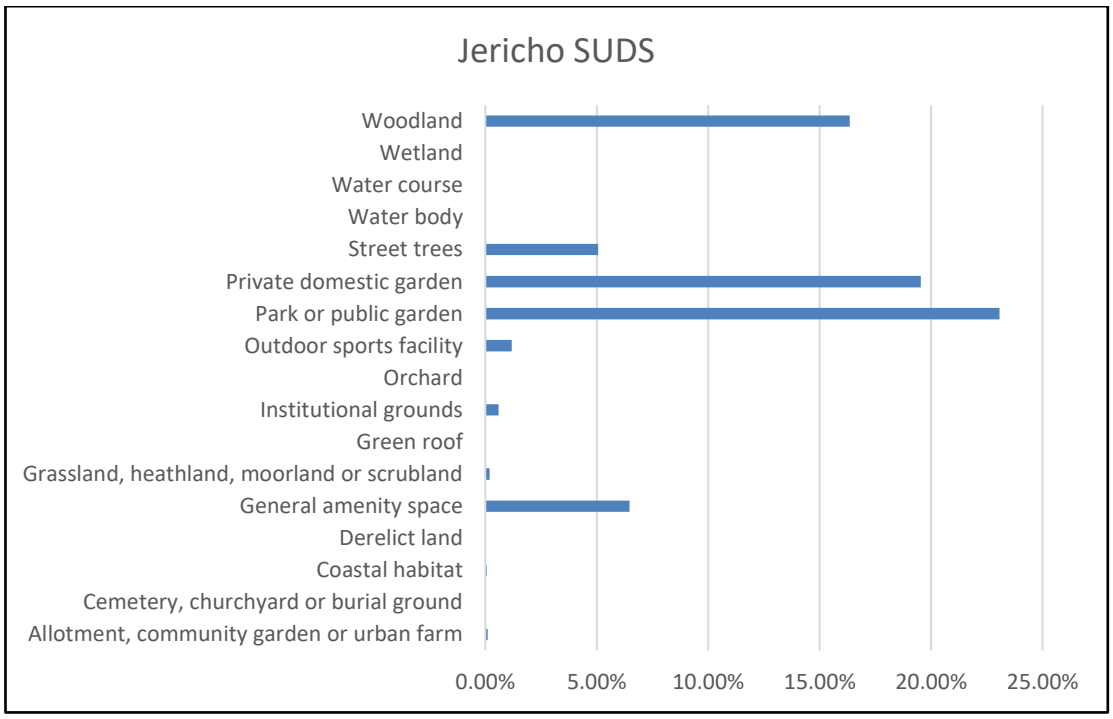


Figure 16: Green Infrastructure typology for Jericho Lane

2.4 Comparing the three demonstration areas using Ward Profiles

Liverpool City Council produces profiles for each ward[13] in the city[14]. Ward profiles show economic and social data about all of Liverpool's 30 wards. Data from the wards that cover the demonstration areas is shown below. Where there are several wards covering the demonstration areas, the most predominant wards are selected for comparison.

The following tables provide a summary for each of these predominant wards. In each summary, each criterion is compared to the average for Liverpool, the national average and the high and low values for the city. An infographic identifies how well each ward performs against these comparators.

The Summary Chart gives an overview of key indicators and measures ward performance against local and national averages.

- The purple line ( ) running down the chart represents the Liverpool average. Anything to the left of the spine is worse than the Liverpool average and anything to the right is better.
- The grey bar ( ) represents the range of performance by all Liverpool's wards.
- The red ( ) or green ( ) triangle indicates the ward performance. Green is better or equal to the Liverpool average and red is worse.
- The blue triangle ( ) marks the national average.

Category	Indicator	Riverside	Liverpool Average	National Average	Lowest City Ward Value	Highest City Ward Value	Ward range and performance in relation to both the city and national average (Centreline = Liverpool Average)
Population	% Population Change 2005-2015	37.1%	5.8%	7.8%	-7.7%	61.7%	
Deprivation	IMD 2015 - % of Area in Most Deprived 10% Nationally	43.8%	45.0%	-	91.7%	0.0%	
Income	Average Household Income 2016	£27,410	£27,287	£37,476	£17,597	£45,489	
Child Poverty	% of Children in Poverty 2014	42.5%	32.1%	20.0%	58.0%	7.4%	
Unemployment	% (Working Age) Worklessness Nov 2016	12.3%	14.0%	8.4%	23.1%	2.9%	
	Average % Claimant Count Apr 2016 -Mar 2017	2.8%	3.4%	1.9%	6.3%	0.7%	
	% Incapacity Benefit Claimants Nov 2016	9.3%	10.8%	6.1%	18.3%	2.3%	
Workforce Characteristics	% Population (Aged 16+) with No Qualifications	27.0%	28.7%	22.7%	47.3%	9.5%	
	% Population (Aged 16+) with NVQ4 or Above	30.7%	22.4%	27.2%	9.9%	44.8%	
Housing	2016 Avg. Property Price - Detached	£149,995	£224,998	£275,719	£137,250	£463,750	
	2016 Avg. Property Price - Semi	£121,995	£149,995	£166,107	£87,748	£330,000	
	2016 Avg. Property Price - Terraced	£89,250	£90,000	£169,962	£50,500	£184,000	
	2016 Avg. Property Price - Flat	£76,950	£101,750	£132,657	£47,950	£147,500	
	% Long Term Vacant Dwellings April 2016	4.2%	2.8%	-	7.2%	0.9%	
Crime	All Crime per 1,000 Persons 2016/17	241.4	102.7	85.8	258.2	37.0	
	Anti-Social Behaviour per 1,000 Persons 2016/17	66.4	40.7	31.0	85.9	16.6	
Health	All Causes Standard Mortality Rates 2014-16 (< 75s)	513.1	497.5	335.0	714.7	247.9	
	Life Expectancy at Birth 2013-2015	77.7	78.5	81.3	74.3	85.3	
Education	% Level 4+ Reading, Writing & Math's Key Stage 2 2016	40.3%	46.0%	53.0%	25.9%	67.0%	

Figure 17: Riverside Ward in Baltic demonstration area

[13] Wards are described in 3.7.2

[14] http://liverpool.gov.uk/council/key-statistics-and-data/ward-profiles/

Category	Indicator	Central	Liverpool Average	National Average	Lowest City Ward Value	Highest City Ward Value	Ward range and performance in relation to both the city and national average (Centreline = Liverpool Average)
Population	% Population Change 2005-2015	80.9%	5.8%	7.8%	-7.7%	61.7%	
Deprivation	IMD 2015 - % of Area in Most Deprived 10% Nationally	18.8%	45.0%	-	91.7%	0.0%	
Income	Average Household Income 2016	£25,993	£27,287	£37,476	£17,597	£45,489	
Child Poverty	% of Children in Poverty 2014	38.3%	32.1%	20.0%	58.0%	7.4%	
Unemployment	% (Working Age) Worklessness Nov 2016	2.9%	14.0%	8.4%	23.1%	2.9%	
	Average % Claimant Count Apr 2016 -Mar 2017	0.7%	3.4%	1.9%	6.3%	0.7%	
	% Incapacity Benefit Claimants Nov 2016	2.3%	10.8%	6.1%	18.3%	2.3%	
Workforce Characteristics	% Population (Aged 16+) with No Qualifications	9.5%	28.7%	22.7%	47.3%	9.5%	
	% Population (Aged 16+) with NVQ4 or Above	29.2%	22.4%	27.2%	9.9%	44.8%	
Housing	2016 Avg. Property Price - Detached	£0	£224,998	£275,719	£137,250	£463,750	
	2016 Avg. Property Price - Semi	£0	£149,995	£166,107	£87,748	£330,000	
	2016 Avg. Property Price - Terraced	£102,500	£90,000	£169,962	£50,500	£184,000	
	2016 Avg. Property Price - Flat	£120,000	£101,750	£132,657	£47,950	£147,500	
	% Long Term Vacant Dwellings April 2016	2.2%	2.8%	-	7.2%	0.9%	
Crime	All Crime per 1,000 Persons 2016/17	258.2	102.7	85.8	258.2	37.0	
	Anti-Social Behaviour per 1,000 Persons 2016/17	85.9	40.7	31.0	85.9	16.6	
Health	All Causes Standard Mortality Rates 2014-16 (< 75s)	685.6	497.5	335.0	714.7	247.9	
	Life Expectancy at Birth 2013-2015	75.9	78.5	81.3	74.3	85.3	
Education	% Level 4+ Reading, Writing & Math's Key Stage 2 2016	32.1%	46.0%	53.0%	25.9%	67.0%	
	% 5+ GCSEs A*-C Incl. English & Math's 2016	57.1%	51.4%	53.8%	36.4%	80.2%	

Figure 18: Central Ward in City Centre demonstration area

Category	Indicator	Mossley Hill	Liverpool Average	National Average	Lowest City Ward Value	Highest City Ward Value	Ward range and performance in relation to both the city and national average (Centreline = Liverpool Average)
Population	% Population Change 2005-2015	-3.2%	5.8%	7.8%	-7.7%	61.7%	
Deprivation	IMD 2015 - % of Area in Most Deprived 10% Nationally	0.0%	45.0%	-	91.7%	0.0%	
Income	Average Household Income 2016	£42,086	£27,287	£37,476	£17,597	£45,489	
Child Poverty	% of Children in Poverty 2014	7.7%	32.1%	20.0%	58.0%	7.4%	
Unemployment	% (Working Age) Worklessness Nov 2016	5.6%	14.0%	8.4%	23.1%	2.9%	
	Average % Claimant Count Apr 2016 -Mar 2017	1.1%	3.4%	1.9%	6.3%	0.7%	
	% Incapacity Benefit Claimants Nov 2016	4.7%	10.8%	6.1%	18.3%	2.3%	
Workforce Characteristics	% Population (Aged 16+) with No Qualifications	15.6%	28.7%	22.7%	47.3%	9.5%	
	% Population (Aged 16+) with NVQ4 or Above	37.9%	22.4%	27.2%	9.9%	44.8%	
Housing	2016 Avg. Property Price - Detached	£372,500	£224,998	£275,719	£137,250	£463,750	
	2016 Avg. Property Price - Semi	£265,000	£149,995	£166,107	£87,748	£330,000	
	2016 Avg. Property Price - Terraced	£169,995	£90,000	£169,962	£50,500	£184,000	
	2016 Avg. Property Price - Flat	£147,500	£101,750	£132,657	£47,950	£147,500	
	% Long Term Vacant Dwellings April 2016	1.9%	2.8%	-	7.2%	0.9%	
Crime	All Crime per 1,000 Persons 2016/17	37.0	102.7	85.8	258.2	37.0	
	Anti-Social Behaviour per 1,000 Persons 2016/17	18.7	40.7	31.0	85.9	16.6	
Health	All Causes Standard Mortality Rates 2014-16 (< 75s)	316.3	497.5	335.0	714.7	247.9	
	Life Expectancy at Birth 2013-2015	82.1	78.5	81.3	74.3	85.3	
Education	% Level 4+ Reading, Writing & Math's Key Stage 2 2016	64.8%	46.0%	53.0%	25.9%	67.0%	
	% 5+ GCSEs A*-C Incl. English & Math's 2016	62.0%	51.4%	53.8%	36.4%	80.2%	

Figure 19: Mossley Hill Ward in Jericho Lane demonstration area

Mossley Hill, in general, performs better than the Liverpool average and often greater than the national average. The only below average criterion is population growth which shows a 3.5% depopulation in the area.

Category	Indicator	St Michael's	Liverpool Average	National Average	Lowest City Ward Value	Highest City Ward Value	Ward range and performance in relation to both the city and national average (Centreline = Liverpool Average)
Population	% Population Change 2005-2015	4.6%	5.8%	7.8%	-7.7%	61.7%	
Deprivation	IMD 2015 - % of Area in Most Deprived 10% Nationally	10.0%	45.0%	-	91.7%	0.0%	
Income	Average Household Income 2016	£33,868	£27,287	£37,476	£17,597	£45,489	
Child Poverty	% of Children in Poverty 2014	18.6%	32.1%	20.0%	58.0%	7.4%	
Unemployment	% (Working Age) Worklessness Nov 2016	12.0%	14.0%	8.4%	23.1%	2.9%	
	Average % Claimant Count Apr 2016 -Mar 2017	3.2%	3.4%	1.9%	6.3%	0.7%	
	% Incapacity Benefit Claimants Nov 2016	9.8%	10.8%	6.1%	18.3%	2.3%	
Workforce Characteristics	% Population (Aged 16+) with No Qualifications	18.3%	28.7%	22.7%	47.3%	9.5%	
	% Population (Aged 16+) with NVQ4 or Above	43.5%	22.4%	27.2%	9.9%	44.8%	
Housing	2016 Avg. Property Price - Detached	£313,500	£224,998	£275,719	£137,250	£463,750	
	2016 Avg. Property Price - Semi	£170,000	£149,995	£166,107	£87,748	£330,000	
	2016 Avg. Property Price - Terraced	£152,750	£90,000	£169,962	£50,500	£184,000	
	2016 Avg. Property Price - Flat	£113,500	£101,750	£132,657	£47,950	£147,500	
	% Long Term Vacant Dwellings April 2016	2.4%	2.8%	-	7.2%	0.9%	
Crime	All Crime per 1,000 Persons 2016/17	77.2	102.7	85.8	258.2	37.0	
	Anti-Social Behaviour per 1,000 Persons 2016/17	43.4	40.7	31.0	85.9	16.6	
Health	All Causes Standard Mortality Rates 2014-16 (< 75s)	479.5	497.5	335.0	714.7	247.9	
	Life Expectancy at Birth 2013-2015	77.7	78.5	81.3	74.3	85.3	
Education	% Level 4+ Reading, Writing & Math's Key Stage 2 2016	32.9%	46.0%	53.0%	25.9%	67.0%	
	% 5+ GCSEs A*-C Incl. English & Math's 2016	58.6%	51.4%	53.8%	36.4%	80.2%	

Figure 20: St Michael's Ward in Jericho Lane demonstration area

St Michaels Ward performs better than the Liverpool average for most criteria.

Looking at data from the four wards covering the three demonstration areas we can see significant differences in the socio-economic conditions.

Table 5: Extract of information from Liverpool Ward Profiles

	Prominent wards in the demonstration areas			
Criteria (sample from tables above)	City Centre	Riverside (Baltic Corridor)	St Michaels (Jericho)	Mossley Hill (Jericho)
Life expectancy at birth (2013-16)	75.6	77.1	77	82.1
% Working age worklessness (2016)	2.9	12	12	5.7
Average household income (2016) £	25,000	27,000	33,000	42,000
% of children in child poverty (2014)	38	42.5	18.8	7.7
All crime per 1000 persons	258	241	77	37
% of population in most deprived 10% nationally	18	43.7	10	0
Population growth 2005- 2015	80	37	4.6	-3.2

There is a 6.5-year difference in life expectancy at birth, with the lowest (75.6 years) in Riverside Ward and highest in Mossley Hill (82.1). There is a correlation between mean wage and life expectancy at birth.

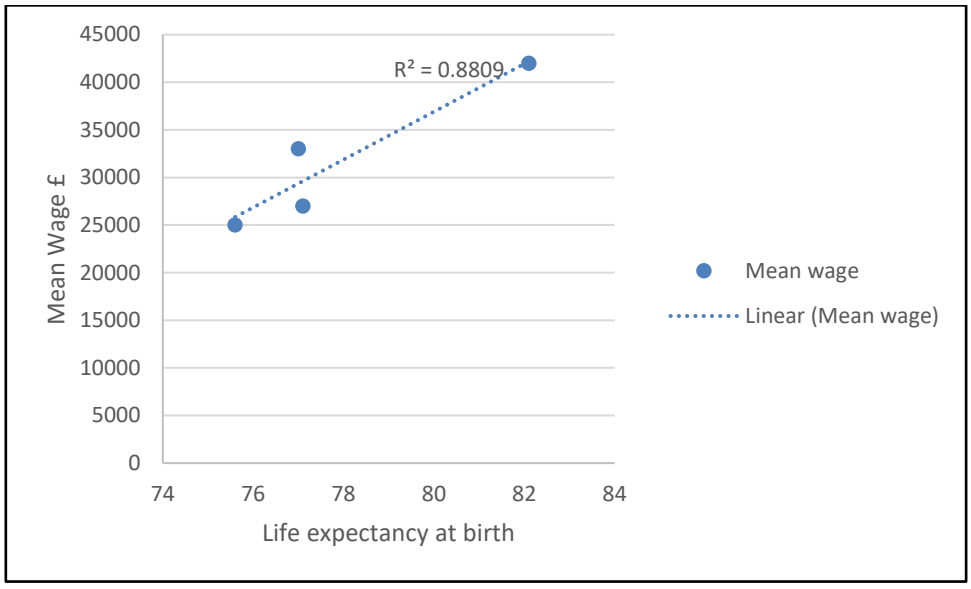


Figure 21: Mean wage/life expectancy at birth in the four demonstration wards

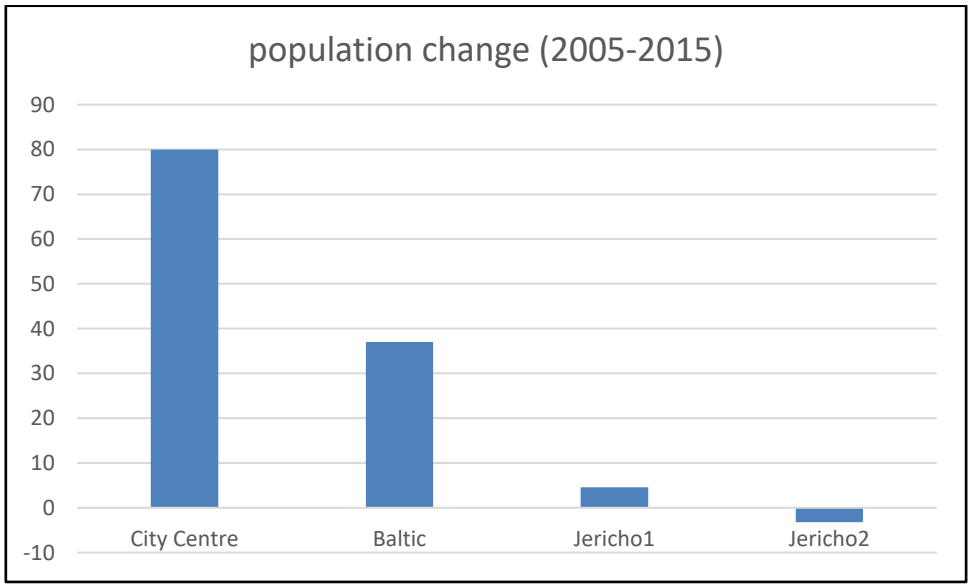


Figure 22: Population change in demonstration wards

The City Centre has experienced a large increase in population, whilst the outlying areas of Mossley Hill and St Michaels have much lower population change, with a reduction seen in Mossley Hill.

3 What are the key issues in each demonstration area?

Much of the information describing the key issues in each demonstration area appears in the Baseline document D3.1, which was prepared for the city. Whilst the inclusion of this data results in repetition, not everyone will read both the city and demo area baseline and so the information has been included to provide context and to avoid too many cross references to other documents.

The Eklipse Framework provides the basis for describing the challenges at the demonstration area level.

The City Diagnosis identified the challenges at a city-wide level. In this report a more detailed assessment is carried out for each of the ten Eklipse challenges at the demonstration area level to provide context for the interventions and assess the key issues that need to be addressed in each in demonstration area and across the demonstration areas.

3.1 Climate Change adaptation and mitigation

Challenge 1 Eklipse Framework measures

Climate mitigation & adaptation	Urban Heat Island, Pluvial flooding, Species movement, Active travel

3.1.1 Climate change resilience

The UK Climate Projections[15] were last issued in 2009 (UKCP09), and are due to be updated in 2018. The projections for the Northwest, and in general for Liverpool, told by UKCP09 are similar to that for the UK and include warmer wetter winters, hotter drier summers, and more extreme and unpredictable weather events. In the Northwest, by the 2080s under a high emissions scenario (Table 4): in winter, mean temperatures could increase by 1.9-4.8ºC and precipitation could increase by 9-50%; in summer, mean temperatures could increase by 2.5-7.3ºC, with daily maximum temperatures increasing by 2.3-10.1ºC, and precipitation decreasing by 2-51%.

In 2010, “Green Infrastructure, how and where it can help the North West of England mitigate and adapt to climate change” was published as part of the North-West Development Agency work on regional climate change resilience[16]. The role that green infrastructure can play in helping to reduce the risks identified, support the benefits that could be achieved and enable the opportunities were clearly identified in the document. The text in green in Figure 23 indicates the elements of risk, benefit and opportunity that green infrastructure can support.

[15] http://ukclimateprojections.metoffice.gov.uk/
[16] http://www.greeninfrastructurenw.co.uk/climatechange/search_start.php (evidence document written by Dr Susannah Gill with mapping by Tom Butlin)

Risks	Benefits
• Increased heat stress and mortality in urban areas for vulnerable populations, and people in poorly designed, insulated and ventilated buildings • Increased uptake of air conditioning, which uses energy and creates waste heat • Negative health impacts from an increase in ozone pollution episodes in summer (due to hotter, sunnier days with lower wind speeds) • Increased incidence of food poisoning and potential increase in transmissible diseases • Increased water deficit, which will cause stress to vegetation, potentially reducing evapo-transpiration and further increasing temperatures • Greater fire risk in upland areas due to drought and high temperatures • Ecological impacts from shifting patterns of agriculture • Expansion northwards and upwards in the ranges of species (may be limited by habitat fragmentation and urban development, and species' dispersal ability) • Loss of mudflats and salt marshes due to sea level rise and coastal squeeze between sea defences, disrupting internationally significant bird-feeding grounds • Additional stress for remnant semi-natural habitats and loss of niche habitats in uplands • Wetter conditions may result in increased accumulation of carbon in peatlands, however the ability of peat to act as a carbon store may be compromised as a warmer climate may result in increased decomposition • Increased pollution runoff in rural lowlands from saturated winter soils • Water quality decreases as a result of low water levels in summer (increasing pollutant concentrations) and a warmer climate increasing algal blooms • Increased saline intrusion into coastal aquifers as a result of sea level rise • Reduced water availability during prolonged droughts; manufacturing may be particularly affected • Increased flood risk from streams, rivers and sewers • Increased coastal flooding risk from increased wave heights (as a result on increased wind speeds) combined with sea level rise • Greater soil erosion as the intensity of rainfall increases • Pressures on vulnerable landscapes from increased visitors and soil erosion • Inundation of coastal aquifers as sea level rise and hydrology changes • Structural damage to buildings and other infrastructure from storms • Impacts on the historic environment (ancient burial sites, buildings, gardens and parks) from altered rainfall, sunshine and humidity • Changes in timing of seasonal events, such as flowering, bud burst and migration has seen the general trend of earlier spring and summer events. The major impacts of this shift are life cycles of species that have evolved together no longer occurring together.	• Wetter conditions may result in increased accumulation of carbon in peatlands, however the ability of peat to act as a carbon store may be compromised as a warmer climate may result in increased decomposition • Lower heating bills and reduced winter mortality rates • Fewer winter air pollution incidents (typically associated with high concentrations of NO_2, CO and VOCs), due to warmer and windier conditions • Migration of species into the region **Opportunities** • New and expanding markets for some sectors, for example, for recreation and tourism • Increase in outdoor-oriented lifestyles as a result of hotter, drier summers; bringing positive commercial, social and health impacts • Increased coastal recreation will provide opportunities for coastal zone regeneration • Agricultural options will broaden out as new crops and varieties become viable

Figure 23: Risks, benefits and opportunities related to climate change in NW England

Key issues to consider

Use of NBS to:

- Highlight the range of benefits to climate change resilience that NBS can provide
- Improve climate change resilience
- Improve data availability for the city
- Develop leadership on climate change resilience

Figure 23 and ***Figure 24*** are taken from 'Green infrastructure: how and where can it help the Northwest mitigate and adapt to climate change?' which was written by Community Forests North West for the North West Development Agency in 2010[17]. Figure 24 shows the number of services that it was considered important to safeguard or enhance in each location across the city. From a total of thirteen possible services, described in ***Figure 23***.

In all the demonstration areas, there are at least four key services that are identified as being important for resilience. In some areas, up to 7 of the 13 services considered important.

The services that are considered important are also assessed in other sections of this report. As a starting point this work identified the need to look at interventions that could provide a

[17] http://www.greeninfrastructurenw.co.uk/resources/GI_How_&_where_can_it_help_the_NW_mitigate_and_adapt_to_climate_change.pdf

range of services, or provide multi-functionality, when designing and implementing nature based solutions.

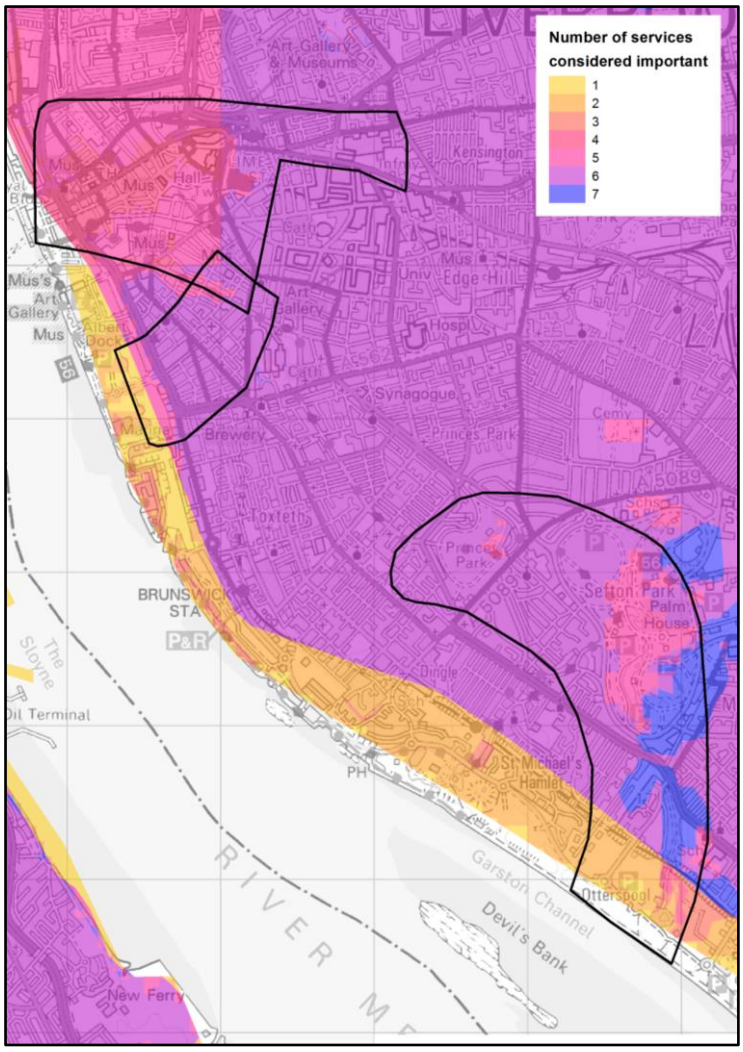


Figure 24: The number of climate change services delivered by green infrastructure that it was considered important to safeguard or enhance in each location

Climate resilience is to a large extent an amalgamation of other issues listed in this report. Climate change exacerbates the urban heat island effect; it increases flood risk; it prompts species movement; and it increases the importance of active and sustainable travel. Targeted development of green infrastructure provides an effective and efficient NBS for the climate challenge, as it provides services that help to mitigate climate change (e.g. reducing emissions), and others that help us to adapt to it (e.g. reducing urban heat islands) (***Figure 24***).

Table 6: Climate change-related services provided by green infrastructure

Mitigation services	Adaptation services
- Carbon storage and sequestration - Fossil fuel substitution - Material substitution - Food production	- Managing high temperatures - Managing water supply - Managing riverine flooding - Managing coastal flooding - Managing surface water - Reducing soil erosion - Helping other species to adapt - Managing visitor pressure

3.1.2 Urban heat island

Using data from the National Health Service Heat Wave Plan[18], we can map the distribution of communities across the cities that have been identified as vulnerable to heatwave. Whilst this data is useful in planning for wider reduction in risks from heatwaves, it does not take into account the impacts of high temperatures on those who work in the most built up parts of the city.

The communities most at risk from heatwave (and potentially Urban Heat Island impacts) are:

- older age: especially over 75 years old, or those living on their own who are socially isolated, or in a care home;
- chronic and severe illness: including heart conditions, diabetes, respiratory or renal insufficiency, Parkinson's disease or severe mental illness.
- infants are vulnerable to heat due to immature thermoregulation, smaller body mass and blood volume, high dependency level, dehydration risk in case of diarrhoea;
- Homeless people (those who sleep in shelters as well as outdoors) may be at increased risk from heatwaves.
- people with alcohol dependence and drug dependence often have poorer overall health and increased social isolation which can increase their risk of heat stress;
- inability to adapt behaviour to keep cool such as having Alzheimer's, a disability, being bed bound, drug and alcohol dependencies, babies and the very young.

High temperatures have a significant impact on health.

"A linear relationship between temperature and weekly mortality was observed in England in summer 2006, with an estimated 75 extra deaths per week for each degree of increase in temperature."[19]

[18] www.gov.uk/.../10088-2902328-TSO-Heatwave-Making_the_Case_ACCESSIBLE.pdf
[19] Heatwave Plan, above

Key issues to consider as identified in the city diagnosis

Use of NBS to:

- Reduce the risk of heat wave to vulnerable communities
- Use of NBS in city centre to reduce the impacts of UHI and the impacts that this has on health and also on economic activity in the city centre
- Develop Star Tools as a model to identify benefits of NBS for reducing UHI

The urban heat island effect in Liverpool is likely to be mitigated by the proximity of the Mersey Estuary. However, despite this mitigation, the STAR tools[20] show that the current low levels of green cover in the city centre will exacerbate the urban heat island effect, and that climate change will likely to exacerbate it further.

The STAR tools are online surface temperature and runoff tools for assessing the potential of green infrastructure in adapting urban areas to climate change. Figure 25 shows the temperature results for both the 'baseline' period (1961-1990) and the 2050s, given a high emissions scenario, which is the closest match to the current emissions trajectory. Both maps use the current green infrastructure cover. They show the modelled maximum surface temperature that will be reached on a hot summer's day in Liverpool.

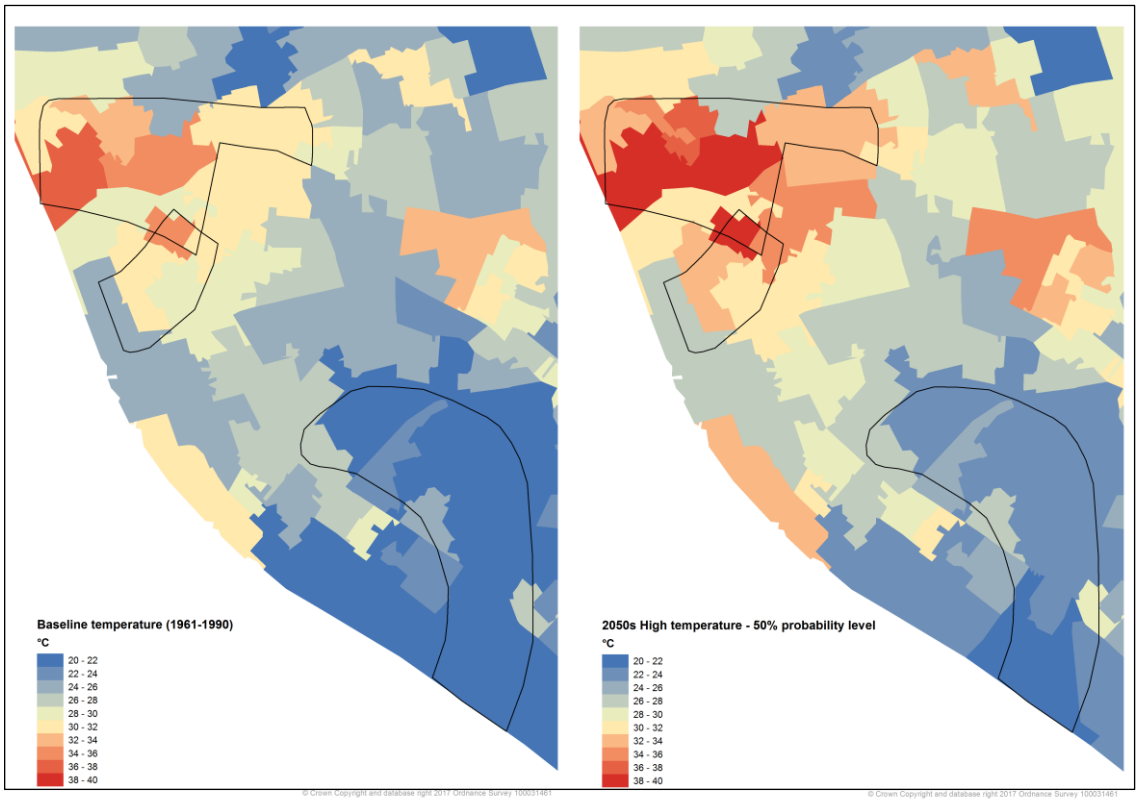


Figure 25: Temperature results from the STAR tools

[20] http://maps.merseyforest.org.uk/grabs

The results show the increase in Baltic Corridor and City Centre temperatures. There is a less pronounced increase in temperature in the Jericho Lane area. The City Centre and Baltic Corridor sub-demo areas are disproportionately affected by high temperatures due to the current low levels of green cover there but conversely the Jericho sub-demo area, with its much higher levels of green cover and the urban heat island effect is much less of an issue.

Relatively few people who are particularly vulnerable to high temperatures (older people and infants) live in the city centre, but of course they may well need to visit the city centre during the day for shopping, excursions etc. The quality of place of the city centre can be affected the urban heat island, and there is a reducing likelihood that people will visit or stay in the city during the very hottest days.

Star Tools has also been used to estimate the reduction in maximum surface temperature that might of be achieved by the planned Urban GreenUP interventions. As can be seen from ***Figure 26***, there is a change of up to 1° C compared to what might have been anticipated in the 2050 scenario, not an insignificant impact when compared to Figure 25.

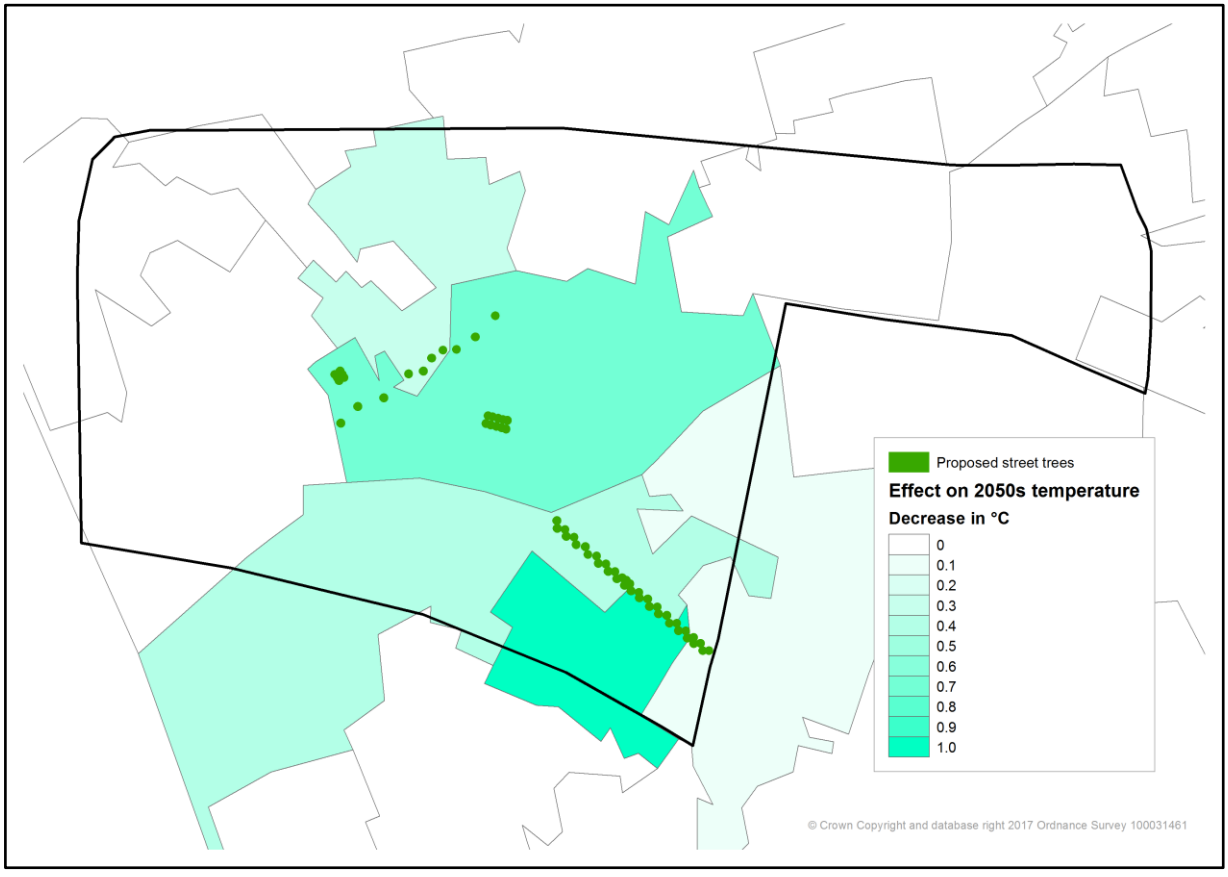


Figure 26: Projected temperature change due to Urban GreenUP interventions in City Centre

3.1.3 Pluvial flooding

Key issues to consider as identified in the city diagnosis

14,430 properties are at pluvial (surface water) flood risk from the 1% (1:100 year) event throughout Liverpool, based on revised integrated hydraulic modelling contracted from the Environment Agency, Liverpool City Council and United Utilities. As Table 1 shows, risk for the 1% event ranges from 382 – 14,430 properties, between the range of building elevations from ground level to 0.2m above ground.

The most recent notable pluvial flood event in Liverpool occurred on 20th July 2010, when a total of 257 residential properties and businesses in Liverpool suffered from internal flooding, some with internal sewer flooding. 50 roads were also affected, the event occurred during a period of drought and a hosepipe ban[21]. At the time, by the end of July, north-west England had its sixth wettest July in a series from 1914, despite the nearby River Ribble gauging station recorded exceptionally low flow on its long-term average baseline[22].

The return period of the 2010 event has not been publicised. Hypothetically, if the event was around the 1:100-year return, it is a conceivable approximation that most properties may be around 300mm elevation from ground, based on the figures in Table 1. However, many properties in the business district, particularly shops, are at ground level with wide doors and no surrounding kerbs or walls, making them particularly susceptible to surface water flooding inflow without physical barriers.

Table 7: Property flood frequency based on different global property elevations. (From hydraulic modelling: United Utilities and Liverpool City Council)

Property Threshold Value (depth of flooding before it can enter a property)	Number of Properties at Risk of Flooding (1 in 100year return period)
0.2m	382
0.1m	1,295
0.05m	2,941
0.025m	5,382
0m	14,430

[21] http://www.bbc.co.uk/news/uk-england-merseyside-10702593

[22] http://nora.nerc.ac.uk/10252/

Within the sub-demonstration zones, pluvial flood risk poses the largest risk, followed by groundwater flood risk, since most ground is built ground. Liverpool One, within the Business Improvement District exists in the former Pool or port of Liverpool – and represents reclaimed and built-up ground, as shown in

Figure 27 and ***Figure 31***.

Throughout all sub-demonstration zones, many properties – residential, commercial and public – reside at pluvial flood risk, as

Figure 27 - ***Figure 29*** show. Table 2 presents the number of properties at flood risk. Clearly, the City Centre is at the greatest risk of surface water flood risk, with 548 and 395 properties being at risk from the 1% and 3.3% event, representing 7% and 5% of all properties in the sub-demonstration zone.

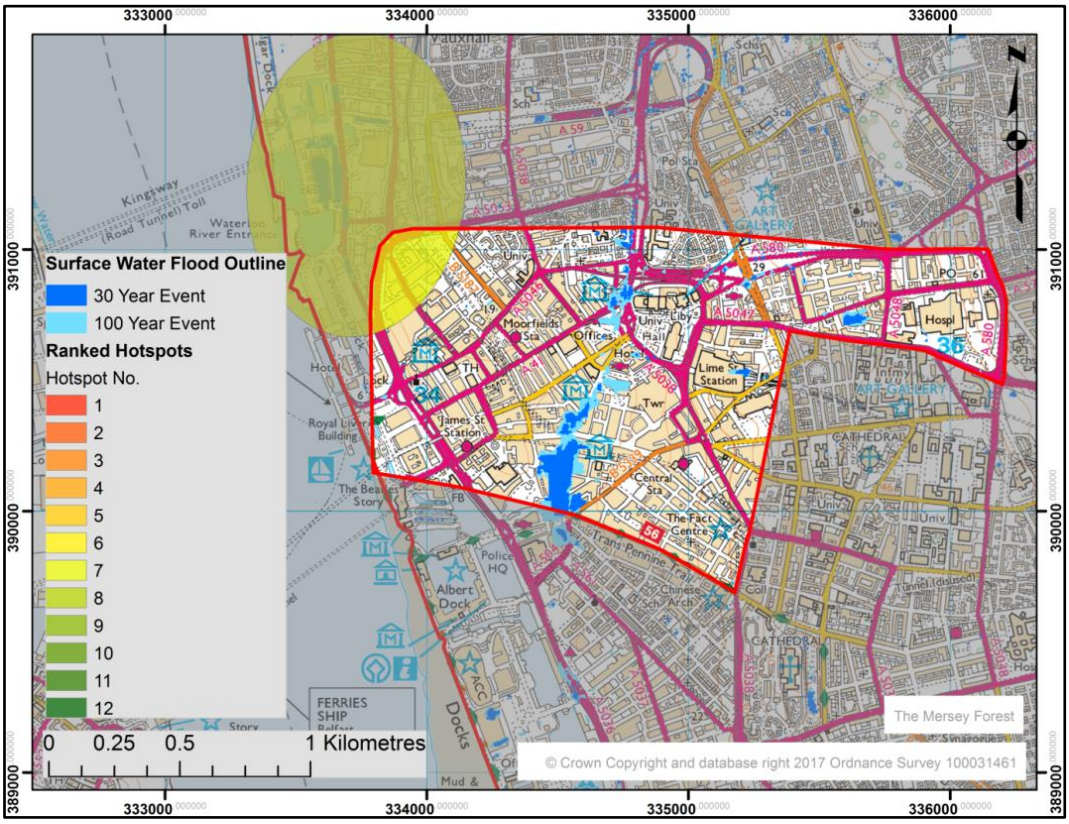


Figure 27: Sub-Demonstration Zone A: Surface Water Flood Outlines and Hotspots (Sensitive-Official Data)

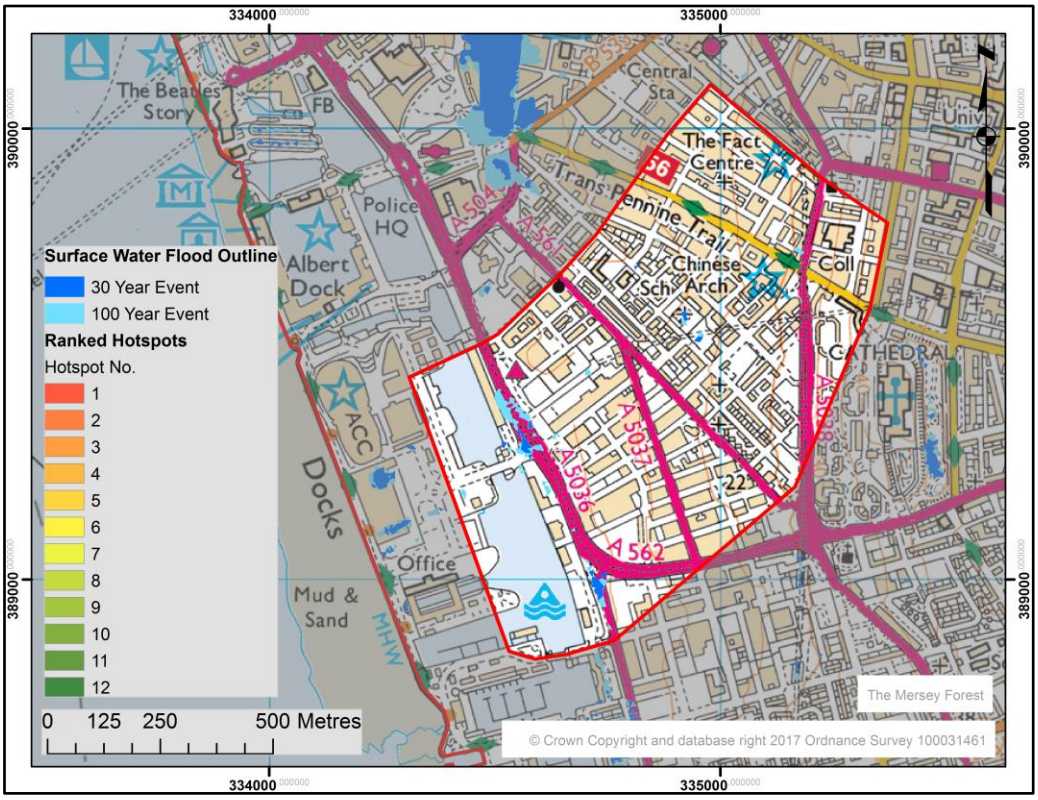


Figure 28: Sub-Demonstration Zone B: Surface Water Flood Outlines and Hotspots (Sensitive-Official Data)

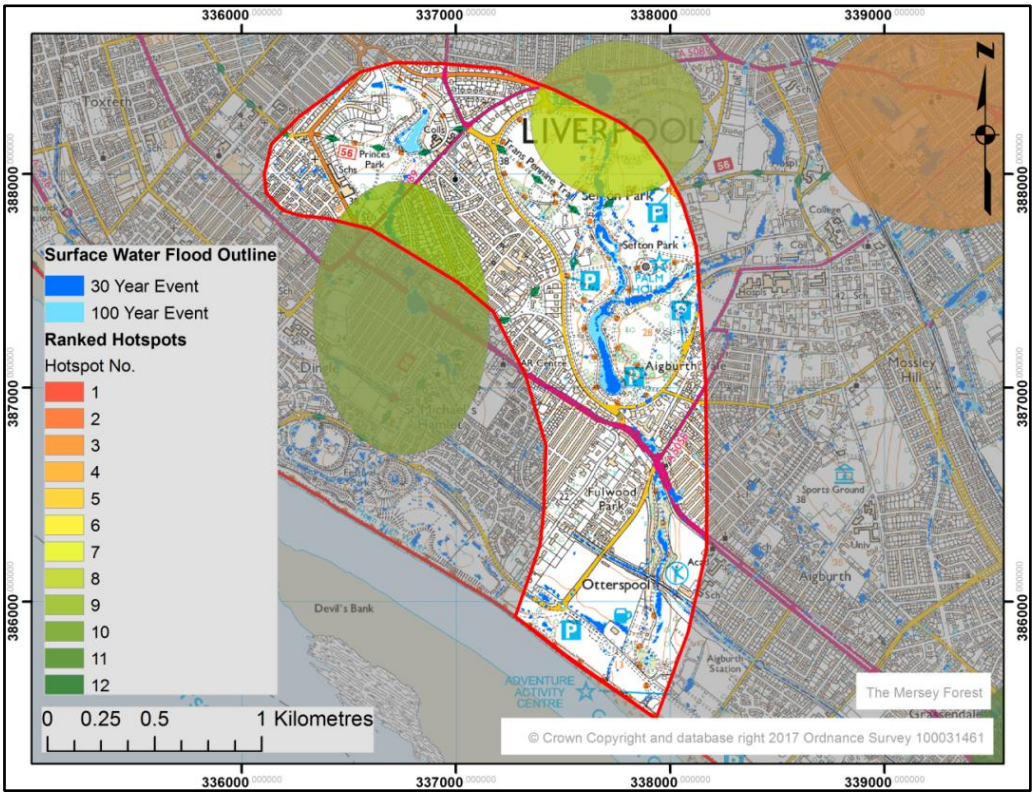


Figure 29: Sub-Demonstration Zone C: Surface Water Flood Outlines and Hotspots (Sensitive-Official Data)

Table 8: Property flood frequency and total number of properties in the sub-demonstration zone

30 year flood event							
Sub-demo area	**Residential**	**Non-residential**	**Total**	**Percentage of Overall Properties**	**Residential**	**Non-residential**	**Total**
City Centre Retrofit	231	164	395	5%	5,659	1,857	7,516
The Baltic Corridor	0	0	0	0%	2,547	340	2,887
Jericho SUDS	170	9	179	4%	4,403	168	4,571
Total	**401**	**173**	**574**	**4%**	**12,609**	**2,365**	**14,974**
100 year flood event							
Sub-demo area	**Residential**	**Non-residential**	**Total**	**Percentage of Overall Properties**	**Residential**	**Non-residential**	**Total**
City Centre Retrofit	287	261	548	7%	5,659	1,857	7,516
The Baltic Corridor	128	3	131	5%	2,547	340	2,887
Jericho SUDS	277	11	288	6%	4,403	168	4,571
Total	**692**	**275**	**967**	**6%**	**12,609**	**2,365**	**14,974**

Monitoring conducted through Merseyside and at sites proximal to the sub-demonstration zones demonstrate that over a 25 time-frame the average loss of vegetation was 5.1% of the total area, with loss occurring at all sites[23].

Pauleit et al (2005:303) observed the corresponding enhanced loss of water from the landscape associated with this:

The highest run-off values were predicted for Scotland Road and Wavertree, which would be expected as they were very densely built-up areas. The lower status sites had on average much higher values for runoff overall. The hydrology model estimated that 75% of the precipitation of a rainstorm event will runoff in lower status sites in 2000 compared with 53% in higher status sites.

Over 25 years there was trend of 'green' to 'grey', even in areas where greenspace was being expanded, such as in private gardens, this was being outpaced by conversion of previously open greenspace into new housing.

Figures 1,5,7 and 11 coincide with one another, high surface water flood risk, principally around Liverpool One occurs where an estuary and port once exited – The 'Pool' of Liverpool.

[23] Pauleit, S, Ennos, R, Golding, Y (2005) Modelling the environmental impacts of urban land use and land cover change—a study in Merseyside, UK. Landscape and Urban Planning. 71, 295 – 310.

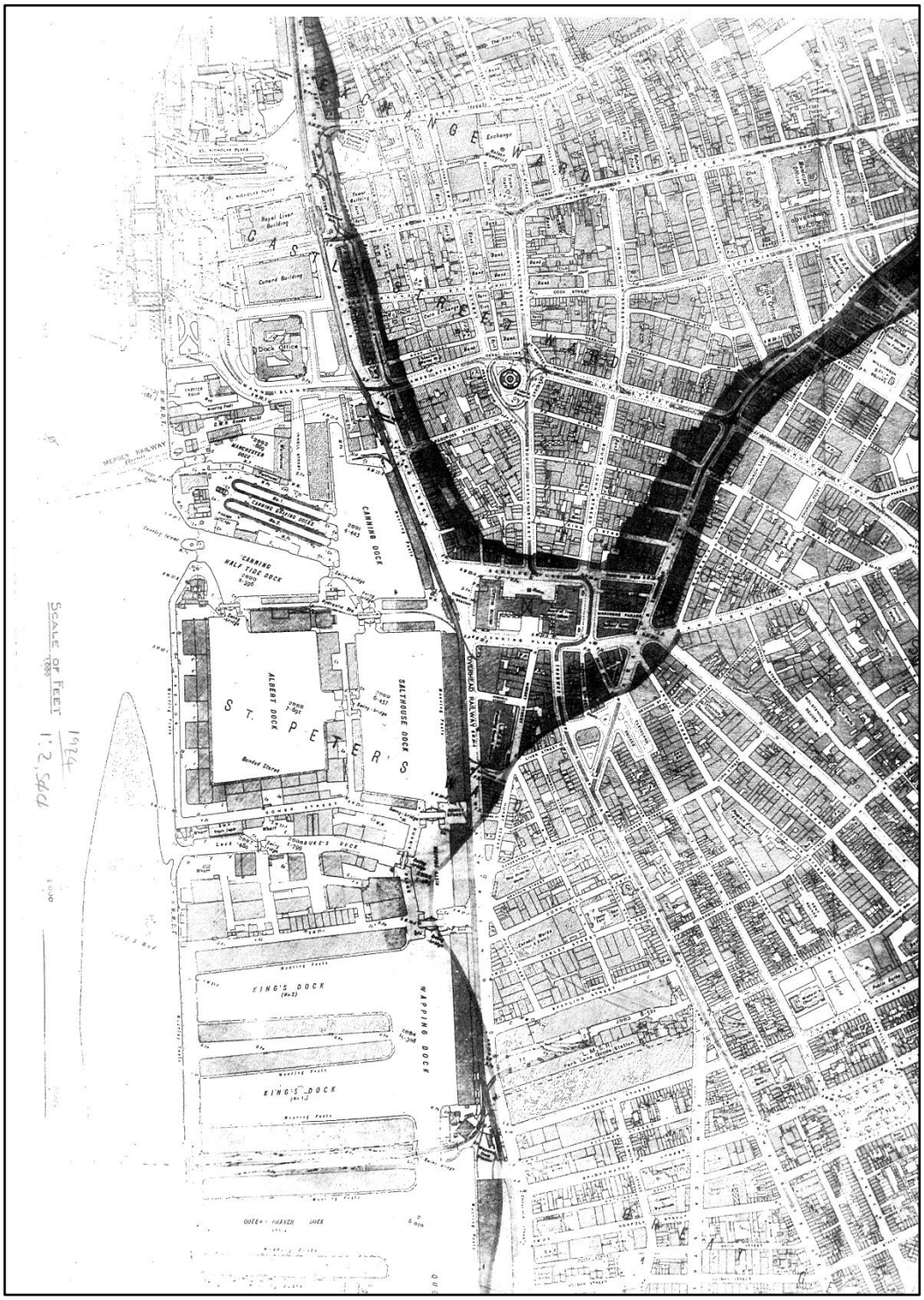


Figure 30: Former Estuary Outlines Superimposed on the 1924 Map of Liverpool's Docks and Central Business District.

Figure 31: The Former Jordan River Confluence – Now the Site of Sefton Park

Natural open streams at the bottom of valleys as in Figure 32 would have once drained the catchments. Now, particularly in sub-demonstration Area A, Baltic Corridor, many of these streams have now disappeared entirely, as **Error! Reference source not found.*Figure 8*** shows. However, the valleys, hollows and topographical depressions still largely exist, for instance around Moss Lake, Fosse Lake, The Pool and on the Jordan River - sub-demonstration zone C and Sefton Park (***Figure 30***, ***Figure 31***)

The natural topographical depressions that would have served to drain the landscape by open-air streams now drain urban hardstanding with the former streams having disappeared. The physical disappearance, or restriction on pipe diameter means that only so much water can be conveyed at any given time, many historical legacy combined sewers could be designed to a less than 10% (1 in 10) event[24], and hence during times of heavy downpours become exceeded and flow occurs overland adopting by enlarge the former valleys of the catchments, with artificial building topography, kerbs and other features routing flow.

In sub-demonstration Zone B, City Centre, focus areas for interventions, including Bold Street, Williamson and Temple Square all have overland flow routes that drain and contribute to overall flooding in the Liverpool One area. Therefore, green infrastructure interventions in these locations are valuable.

[24] Ward, AD and Trimble, SW. 2003. Environmental Hydrology: Second Edition. Oxon: CRC Press

Some catchments, like that of the former Upper and Lower Jordan, predominantly now drain into sewer systems that capture drainage and route it in other directions. Sefton Lake formerly was at the confluence of two rivers, but because of drainage capture, a borehole abstracting groundwater from the Triassic Sandstones now recharges the lake at an average rate of 15 litres per second[25]. The Lower Jordan no longer provides base flow into Sefton Lake.

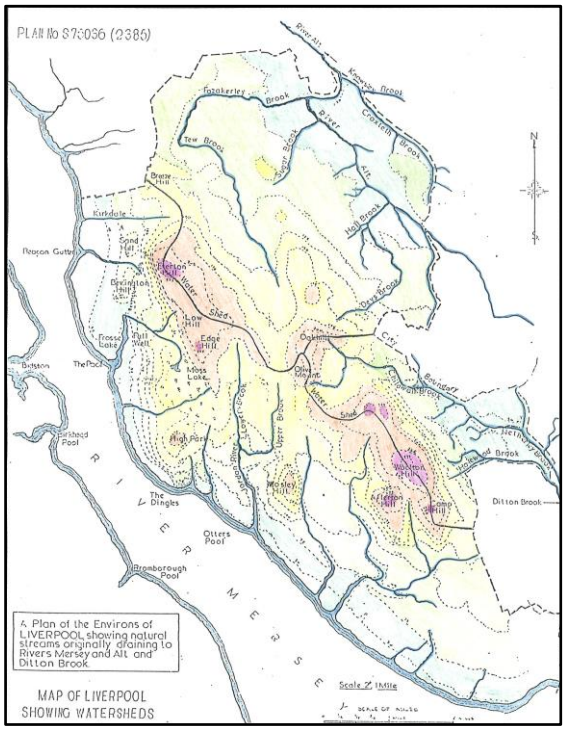


Figure 32 : Historic catchments and watercourses of Liverpool

[25] Theobalds J, Small S, Wilton M, (2005) Sefton Park Restoration and Improvement Civil Engineering Strategy HLF Stage 2. Job number 118784. Report ref REP/118784/C001. ARUP Liverpool. Issue 1. Pages 1 – 67.

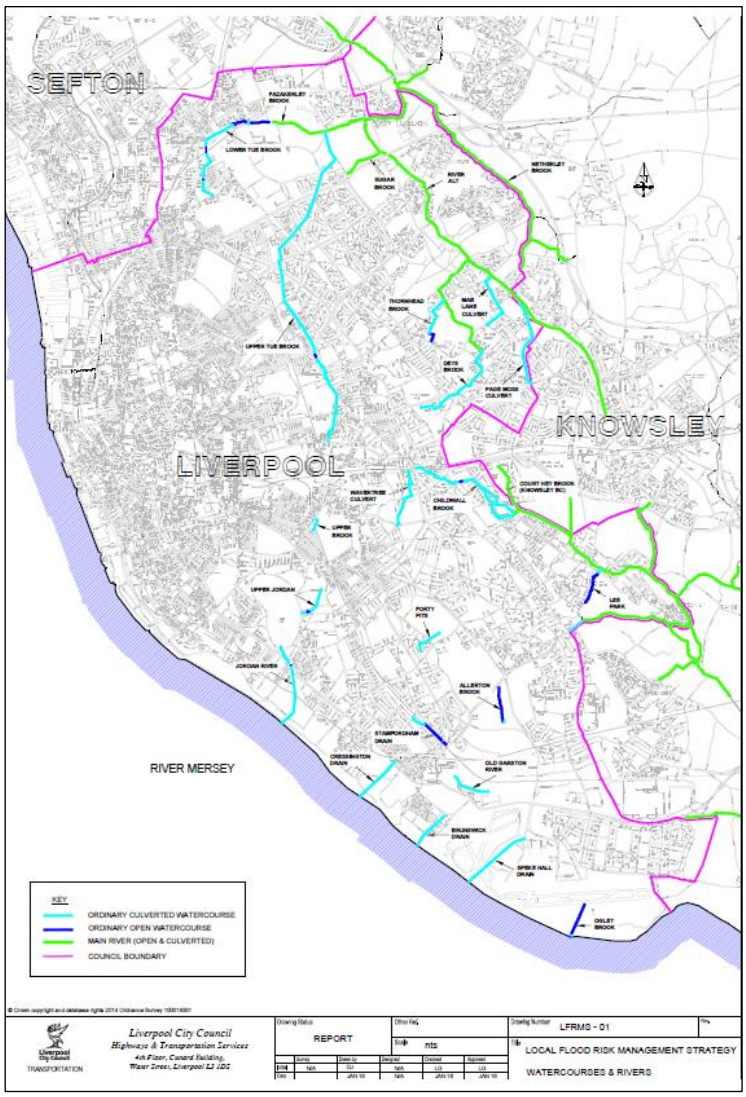


Figure 33: Present-day watercourses of Liverpool – piped and open channels

Previous modelling by Jeremy Benn Associates for Liverpool noted the following:

Liverpool should be a focal area for low density urban tree planting. Tree coverage of 10% in Liverpool, the target advocated in the Mersey Forest Plan, is modelled to have a benefit of greater than £5M in a 1:100 event in terms of flood damages avoided. This shows the benefit of the existing tree coverage and the value in retaining and enhancing tree coverage through the delivery of street trees and low-density planting initiatives. This flood risk benefit should be judged against concerns about safety and maintenance costs related to existing urban trees.[26]

[26] JBA (2017) Merseyside Strategic NFM Targeting Maps: User Guide. The Rivers Trust, Natural Course (EU LIFE IP) and JBA. Unpublished Technical Paper. Skipton:JBA. 1 – 21.

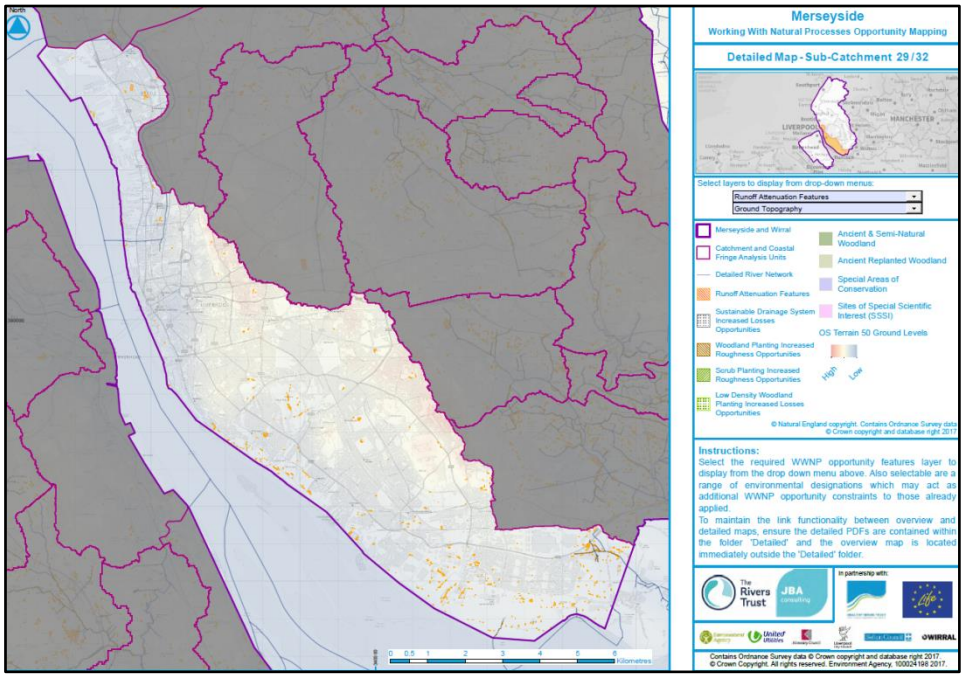


Figure 34: Runoff Attenuation Feature Opportunities Through the Liverpool Area

Currently, it is understood that that overland flow through the city contributes to the large flood zone at the former Pool of Liverpool and Fosse Lake – which covers an area around Liverpool one at 35,945 and 75,111m^2 for the 3.3% and 1% event (***Figure 36***). If this water were estimated to be 1m depth across those entire footprints, that would correspond to 35,945 and 75,111m^3.

The hydraulic model which was used to produce the outputs, which is believed to be an InfoWorks ICM model, capable of modelling in-pipe and overland flows, including depths and velocities, can have a reporting location function added to it to in-effect gauge flows sheeting-across the land at defined areas. TUFLOW, another hydraulic model, has the reporting locations function, and it is anticipated that InfoWorks ICM has the same[27] determining the volume and speed over any given line through the design storm.

In context of the KPIs and assessing the impacts of trees overall, it is recommended that this analysis take place, to determine the efficacy of trees on reducing flood risk in sub-demonstration zone A – the area of highest risk (Figure 34)

Table 8: Hydraulic model analysis of this sought would be a departure from the Eklipse and G-Val framework, but the outputs and findings would be site-specific and relevant to the Urban GreenUP programme.

Clearly, as Figure 35 and Figure 36 show, the damages avoided through green infrastructure interventions are considerable in terms of economic damages to properties avoided. In the case of Liverpool One, these are commercially profitable and valuable units. However, what is not yet known is how much water needs to be captured by tree pits, trees and detention tanks

[27] https://www.tuflow.com/Download/TUFLOW/Releases/2016-03/TUFLOW%20Release%20Notes.2016-03.pdf , pp. 18

to remove the risk in Liverpool One, which is hydraulically connected to the sheet overland flow that arc North-East to South in ***Figure 36***. Analysis of the InfoWorks ICM model would facilitate the accurate determination of volumes travelling across the CBD throughout the entirety of a storm and at snapshots in time at various user defined locations.

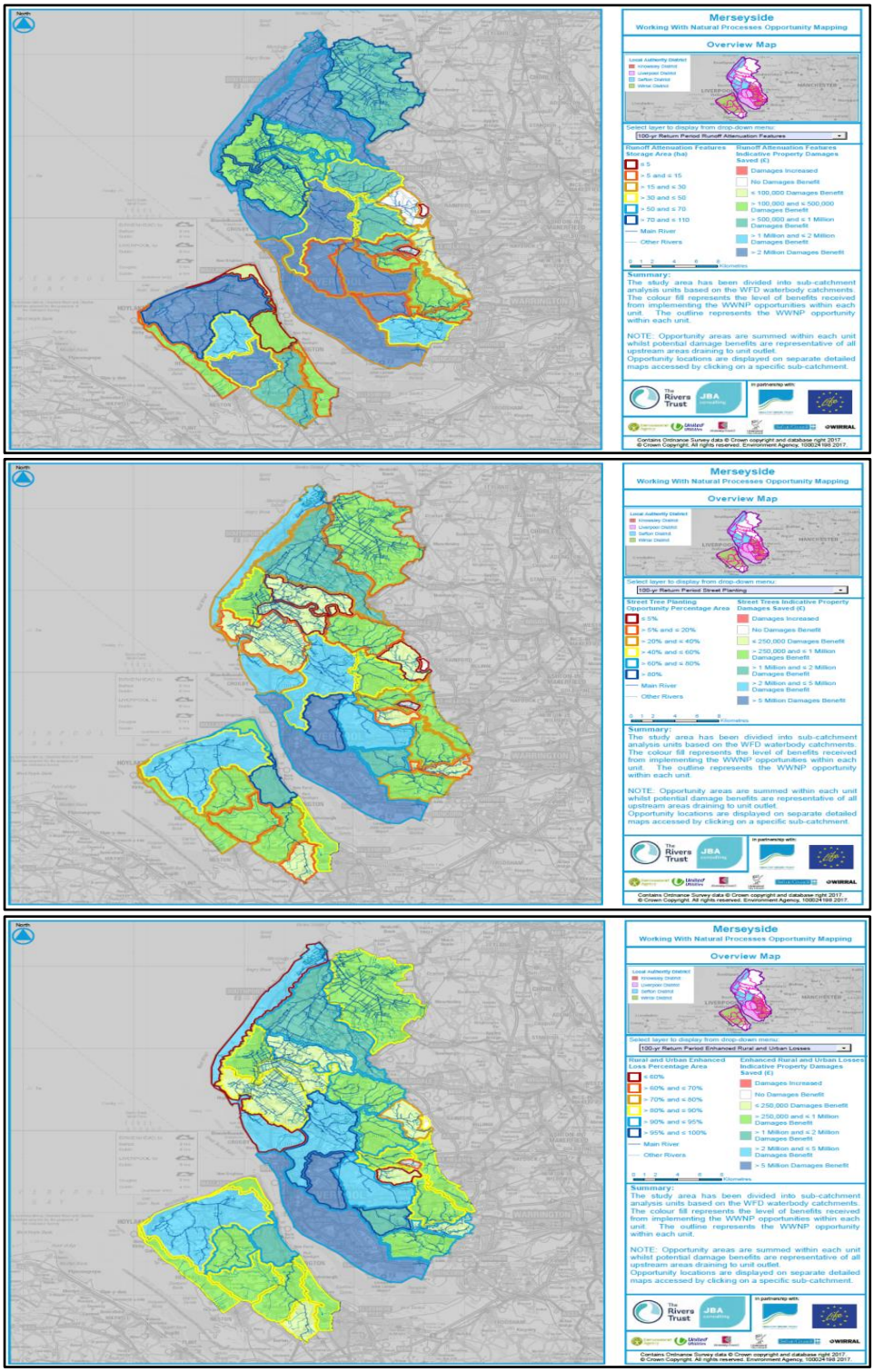


Figure 35: Runoff Attenuation Feature (ha), Street Tree Percentage Area (%) and Rural and Urban Enhanced Loss Percentage Area (%) Effects on Indicative Property Damages Saved (£)

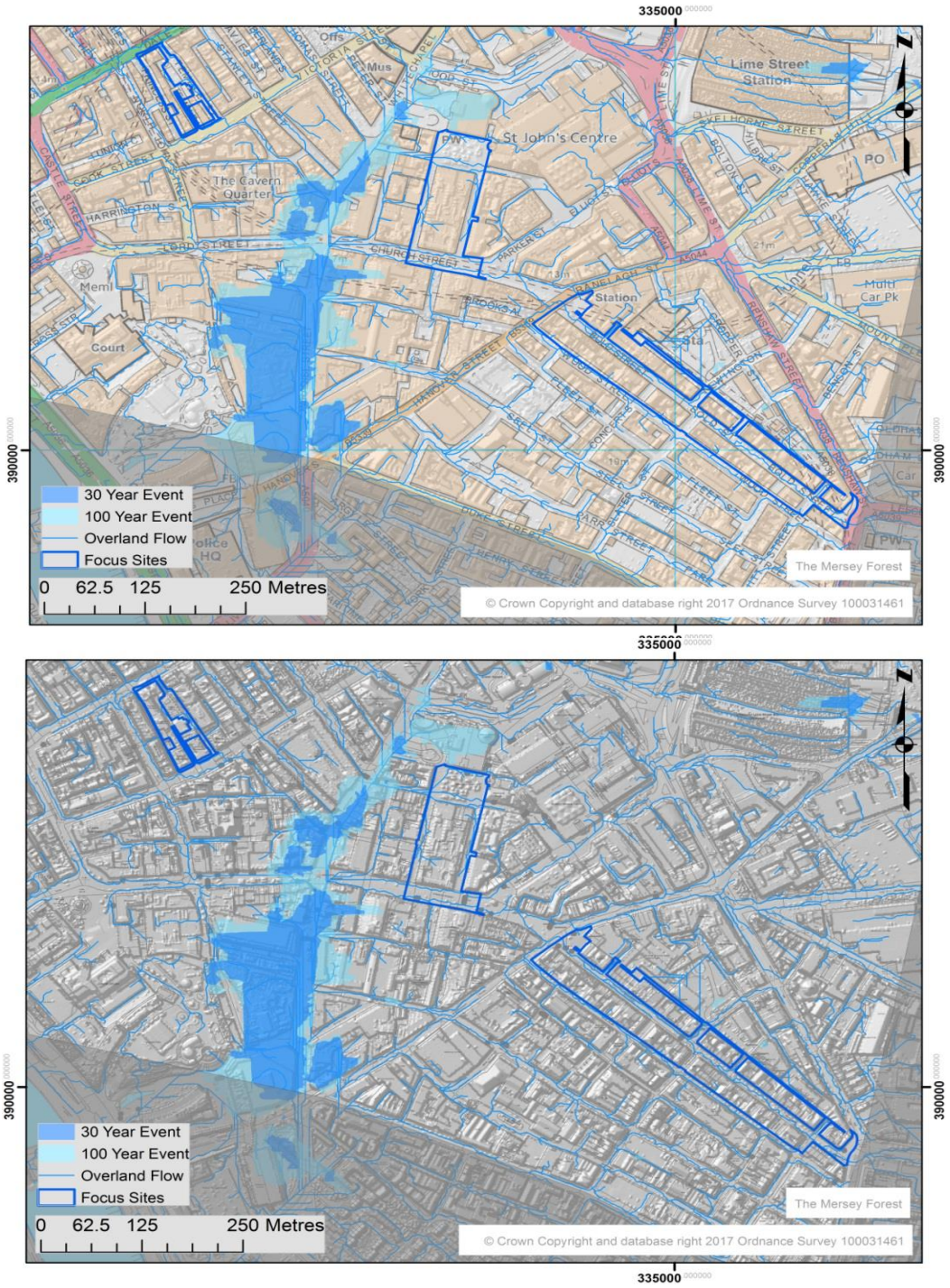


Figure 36: Overland Flow, 1% (1:100) and 3.3% (1:30) Surface Water Flood Outlines (Sensitive-Official) in relation to the focus sites in sub-demonstration zone

3.1.4 Species Movement

As the climate changes, species tend to move northward and/or toward high elevations to stay within their preferred climate envelope.

Networks and corridors of green infrastructure can assist in this movement. However, where there are gaps in the network, species movement can be slowed or stopped. This may mean a loss of species occurs as the climate changes.

The Condatis[28] programme has been developed by the University of Liverpool. Condatis is a decision support tool to identify the best locations for habitat creation and restoration to enhance existing habitat networks and increase connectivity across landscapes.

Using the green infrastructure mapping for the city, Condatis can be used to identify the key flow pathways for species movement through the city, from south to north. Three habitat types have been considered here.

- Trees and woodlands
- Intensively managed grassland
- Less intensively managed grassland

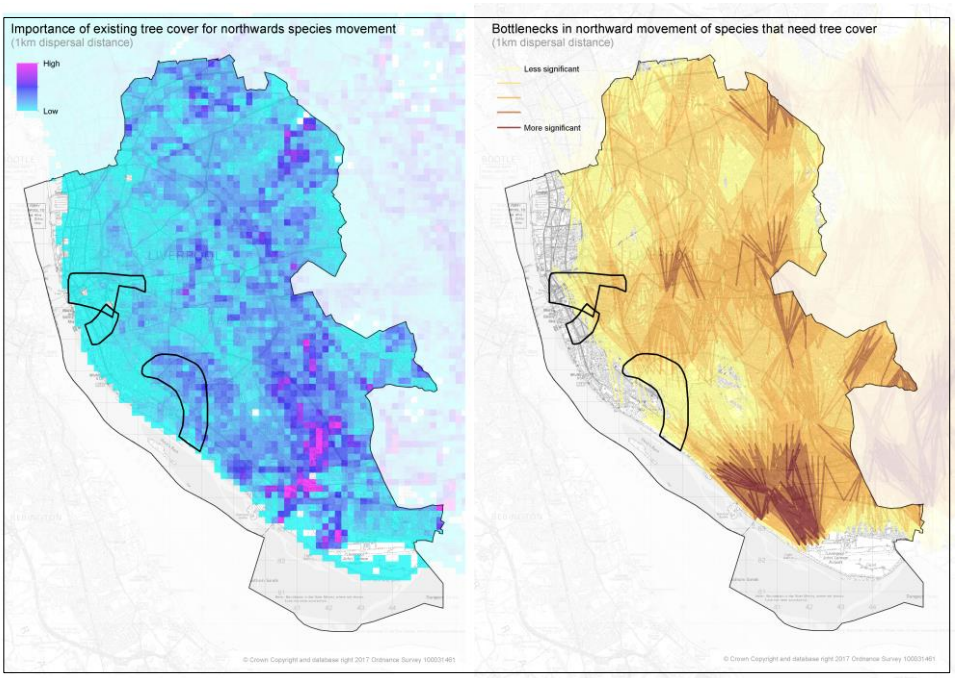
Mapping for each of these habitat types was based on the green infrastructure typology map. The results are somewhat limited by the limited correspondence between the green infrastructure types and the categories of habitat favoured by relevant species.

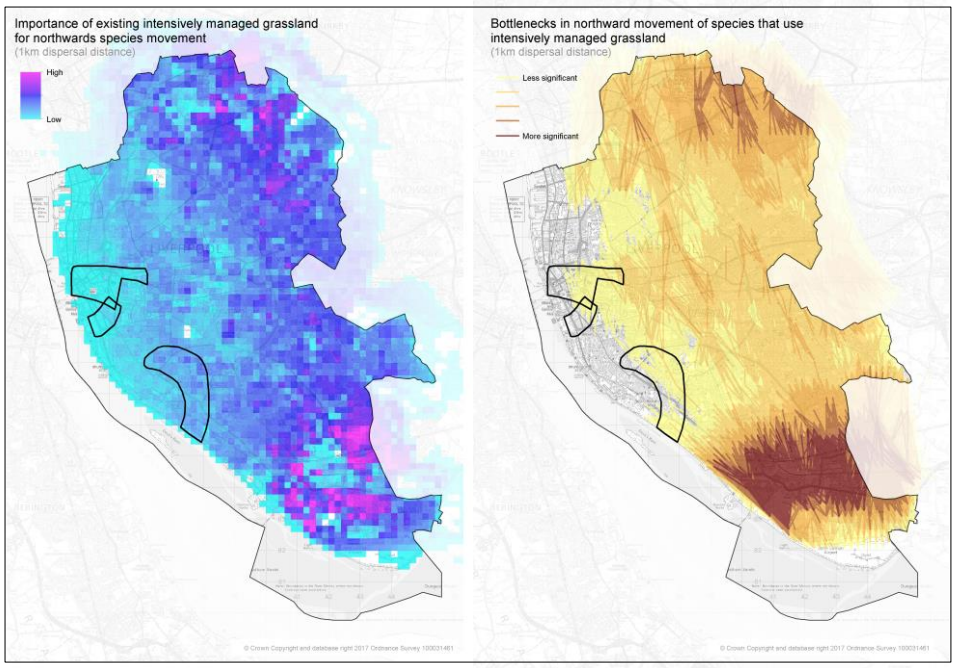
Key issues to consider

Use of NBS to:

- Increase connectivity of habitats
- Target areas with lower levels of green infrastructure
- Promote Lawton principles - more, bigger, better managed and well-connected habitats across the city.

[28] http://wordpress.condatis.org.uk/


Importance of existing tree cover for northwards species movement
(1km dispersal distance)
High
Low
Bottlenecks in northward movement of species that need tree cover
(1km dispersal distance)
Less significant
More significant


Importance of existing intensively managed grassland for northwards species movement
(1km dispersal distance)
High
Low
Bottlenecks in northward movement of species that use intensively managed grassland
(1km dispersal distance)
Less significant
More significant

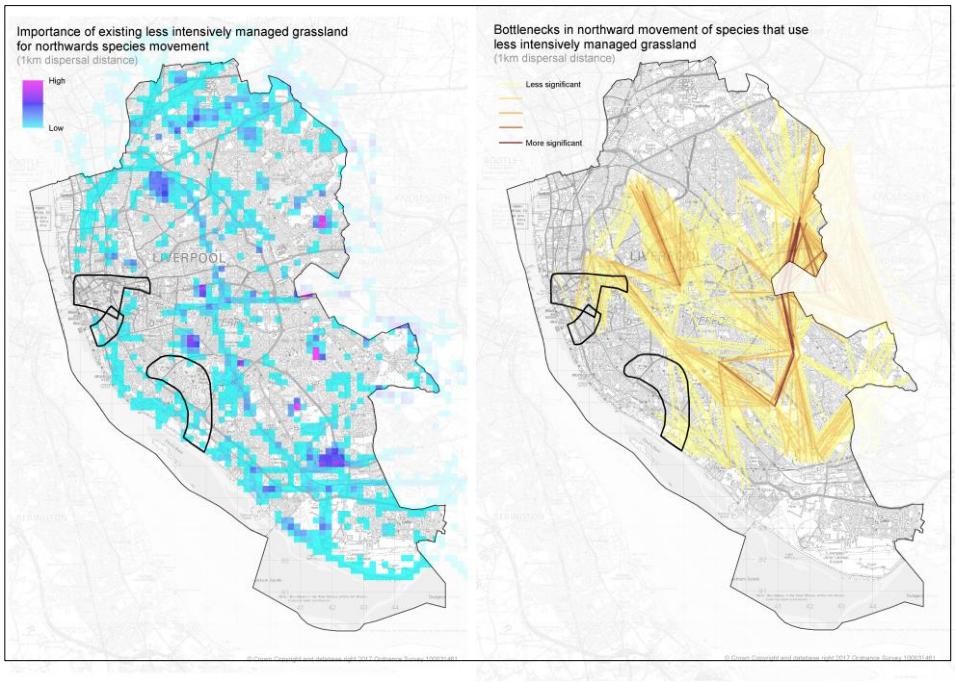


Figure 37: Results from Condatis for northward movement of species using three different habitat types

Climate change is likely to prompt many species to move northwards in search of cooler temperatures. The Condatis software[29] produced by the University of Liverpool can give an understanding of where existing habitat is assisting that movement, and where there are bottlenecks. ***Figure 37*** shows these results for three different habitat types: trees, intensively managed grassland, and less intensively managed grassland.

It is clear that the sub-demo areas, especially City Centre and Baltic Corridor, are part of a built-up corridor along the bank of the Mersey that offers little connectivity for wildlife. There is much more habitat and connectivity in the eastern half of the city.

However, there is some movement of species through the sub-demo areas, especially Jericho, and this could potentially be facilitated further by addressing some of the identified bottlenecks. These are primarily located heading north from the northern edge of the Jericho sub-demo area, and passing through the eastern end of the City Centre sub-demo area, for all three habitat types.

The tree cover in the Jericho sub-demo area is of moderate importance for the northward movement of species. The low levels of tree cover in the other sub-demo areas are of low importance. There are moderately significant bottlenecks both south and north of the Jericho sub-demo area, and passing through the eastern parts of the other two.

The pattern of importance of existing habitat and the pattern of bottlenecks are similar for intensively managed grassland.

[29] Wallis, D.W., and Hodgson, J.A. Condatis; software to assist with the planning of habitat restoration. Version 0.6.0. www.condatis.org.uk. http://dx.doi.org/10.5281/zenodo.13951

The less intensively managed grassland in the sub-demo areas is of little importance for the northward movement of species. However, there are some important patches near the sub-demo areas, most notably Toxteth Park Cemetery. There are moderately significant bottlenecks just to the east of the Jericho sub-demo area and passing through the eastern part of the City Centre one.

3.1.5 Active travel

Replacing trips normally made by car with increased levels of cycling and walking can help to reduce greenhouse gas emissions. Short car journeys are a key target for active transport. They are frequent, often short journeys that could be walked or cycled.

Liverpool's Green Infrastructure Strategy[30] highlighted the need to develop areas that encouraged walking and cycling, these linked networks of green infrastructure to areas of housing and short trip destinations such as schools, health centres, places of work and shops.

Key issues to consider as identified in the city diagnosis

Use of NBS to:

- Use of NBS to increase active travel
- Links to existing software such as Strava to measure access and identify options for targeting investment in active travel.

[30] http://www.greeninfrastructurenw.co.uk/liverpool/

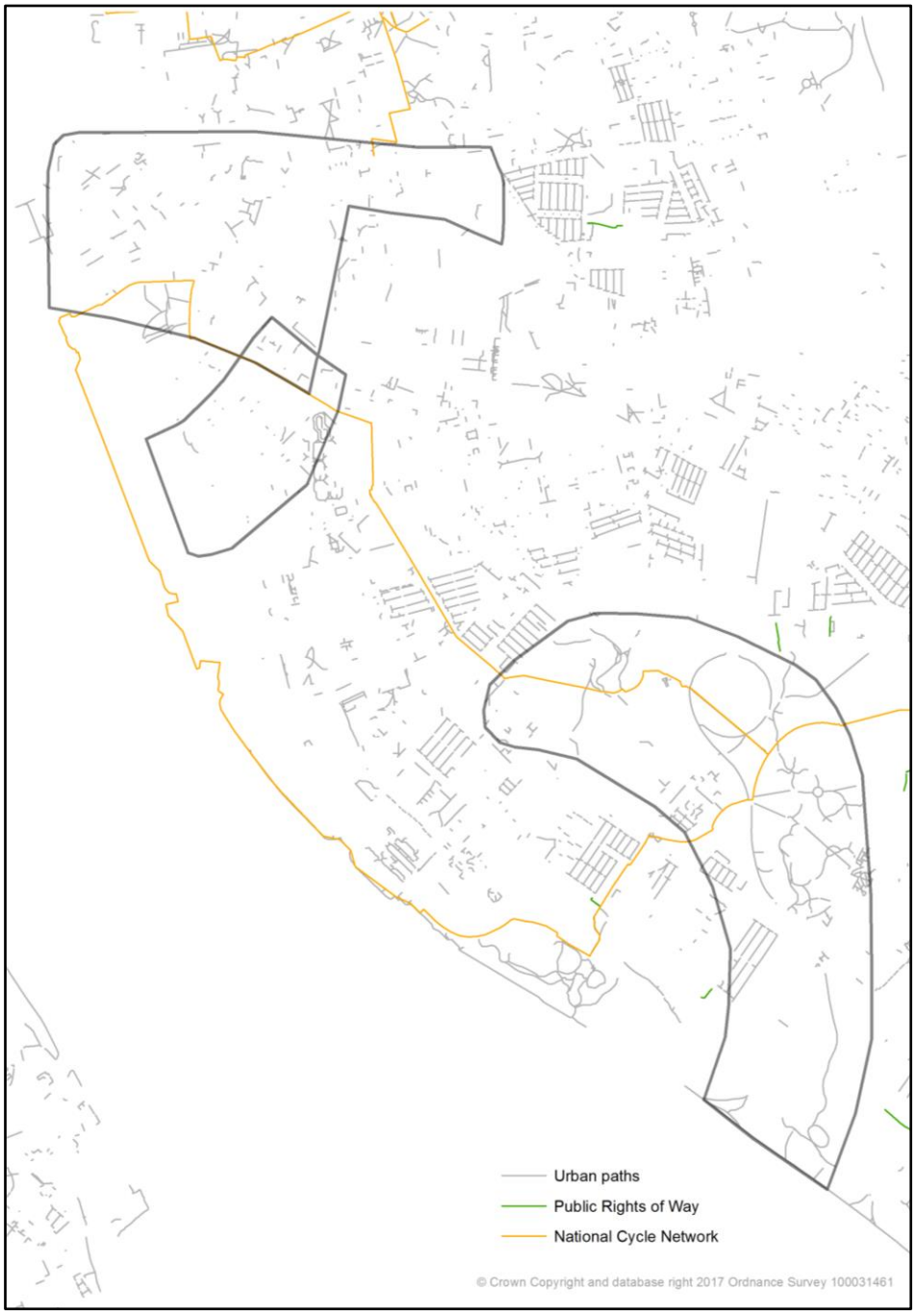


Figure 38: Active travel routes

The sub-demo areas have an extensive network of active travel routes. Although there are not many designated Public Rights of Way, there are many less formal urban paths, and the three sub-demo areas are well connected by cycle routes.

The Jericho sub-demo area has the most active travel routes, and the Baltic Corridor the fewest. The dense road networks in the city centre tend to preclude off-road routes to an extent, but there are some pedestrianised streets and cycle lanes.

Figure 39 shows use of active travel routes by runners and cyclists (as recorded on Strava). Key routes include:

- Routes through Sefton Park
- Routes through Princes Park
- Routes through Otterspool Park
- Routes along the waterfront
- The Strand and roads connecting to it
- Princes Avenue, linking the sub-demo areas

Figure 39: Heat map of running and cycling recorded on Strava[31]

[31] http://labs.strava.com/heatmap/#13/-2.96579/53.38840/blue/both

3.2 Water management

Challenge 2 Eklipse Framework measures

Challenge 2 Water Management	**Reduced flood risk, improved water quality**

3.2.1 Reducing flood risk

Liverpool is at risk from flooding from multiple sources, including from rivers, namely the Mersey, but also from 10 streams which are mostly culverted.

Key issues to consider

Use of NBS to:

- Reduce flood risk
- Improve water quality.
- Improve ecological status of water bodies

3.2.2 Flooding in the demonstration areas

As Section 3.1.3 demonstrates, pluvial flood risk is the main risk in the demonstration areas.

Within the demonstration areas, one property is at risk from main-river flooding from the River Mersey, this is the Liverpool Pier Head Ferry Terminal.

Outside the demonstration areas, on the quayside and riparian development sites along the Mersey Estuary there is considerable risk from: sea level risk, a tidal surge, river flooding, a 'tide locking' event of high river flows and high-tide – resulting in the inability of the Mersey to discharge itself to sea – raising water levels.

Recently, Storm Brian led to a Storm Surge on the West Coast of the UK[32].

No Environment Agency formal flood defences exist along the Mersey.

- Within the Baltic Corridor sub-demonstration area, high ground and masonry lined channel exists for a length of 2,007.4m (Figure 42). This has a condition grade 2, denoting 'minor defects that will not reduce overall performance of asset'. The grading system operates from 1 to 5, very good to very poor[33].

[32] http://www.bbc.co.uk/news/av/uk-41706937/huge-waves-crash-over-seafronts-in-storm-brian-surge

[33] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/291126/scho0509bqat-e-e.pdf

Figure 40: Flood Defence Asset Type and National Flood Zones 3 (1:100) and 2 (1:1,000) in Relation to Liverpool and the Sub-Demonstration Zones.

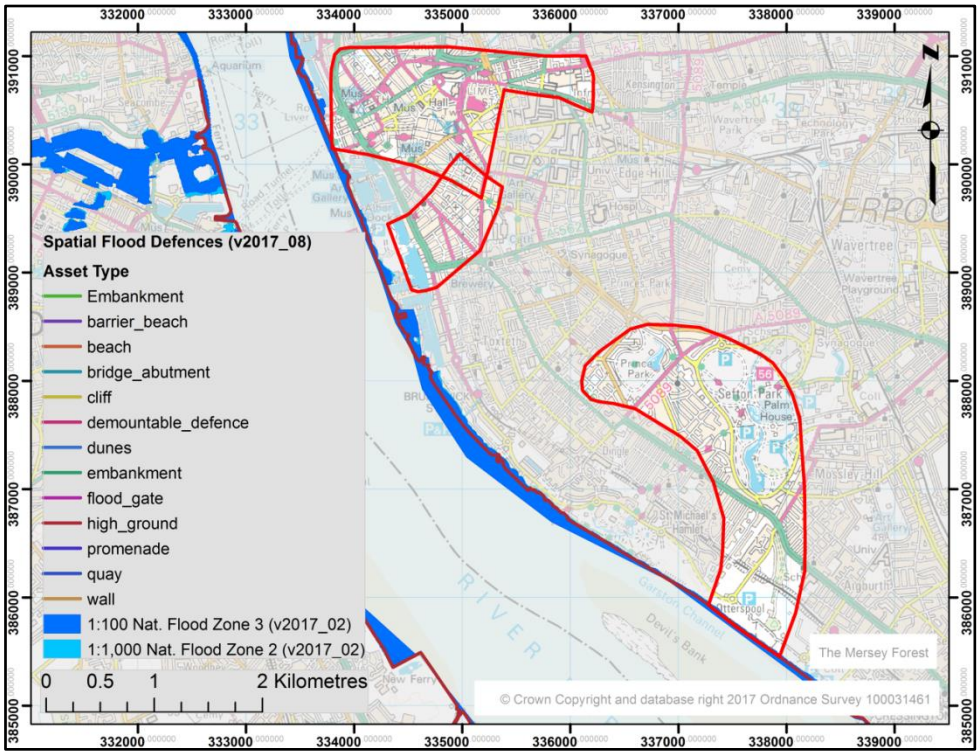


Figure 41: Flood Defence Asset Type and National Flood Zones 3 (1:100) and 2 (1:1,000) in Relation to Liverpool and the Sub-Demonstration Zones

The national tidal and sea level facility has produced predictions on future tide elevations, notably on November 5th 2017 a peak tide is predicted at 10.01mAOD (Above Ordnance Datum), with September 19th 2024 having a prediction of 10.29m[34]. With the new DEFRA climate change impact projections[35], and sea level rise[36], tidal surges could be a risk that is compounded into the future.

[34] http://www.ntslf.org/tides/predictions

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

[36] https://www.gov.uk/government/publications/shoreline-management-plans-smps/shoreline-management-plans-smps (SMP 22 Great Ormes Head to Scotland (North West England and North Wales) Lead: Blackpool Borough Council)

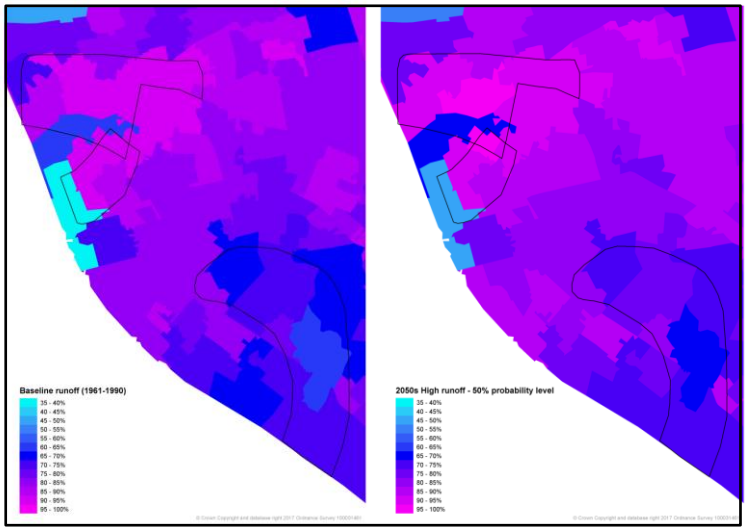


Figure 42: Runoff results from the STAR tools

Almost all of the watercourses in and near the sub-demo areas are culverted. This means that almost all of the flood risk comes from the danger of culverts and sewers being overwhelmed by storm events involving large quantities of precipitation over a short time period. In other words, it is pluvial or surface water flood risk.

STAR tools (see the urban heat island section above and ***Figure 42***) show that, in the City Centre and Baltic Corridor sub-demo areas, the proportion of precipitation that will flow over the ground, rather than soaking into it, is high. This runoff can potentially contribute to surface water flooding. The reason for the high proportion of runoff is the high proportion of sealed paved surfaces, and the low capacity of the city's Victorian waste water system. In addition, flooding can be exacerbated by blocked gulley pots and grids during stormy weather or periods of leaf fall.

In the Jericho sub-demo area, in contrast, the proportion of runoff is relatively low, due to the relatively low proportion of sealed surfaces.

Star Tools can also be used to project the likely impact on surface water runoff of the planned Urban GreenUP interventions (***Figure 43: Projected decrease in surface water runoff based on planned interventions, using Star Tools to model percentage decrease in runoff.*** (***Figure 43***). This shows a 0.7-0.8% reduction in runoff based on the planned interventions. However the tool does not take into account any tree pit engineering that is designed to maximise the impacts of evaporation and retention of water.

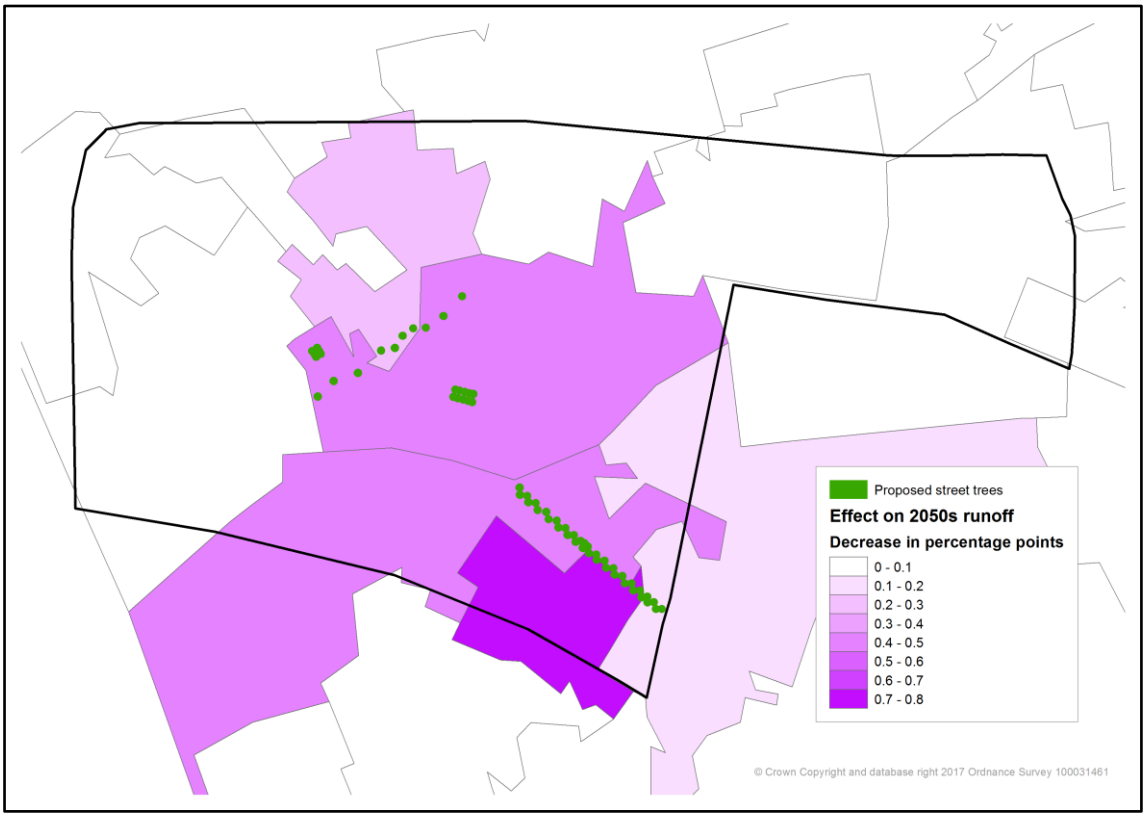


Figure 43: Projected decrease in surface water runoff based on planned interventions, using Star Tools to model percentage decrease in runoff.

3.2.3 Water quality

Very little suitable data on water quality is available for the sub-demo areas. Data from United Utilities[37] confirms that drinking water quality is, unsurprisingly, not a problem. However, whilst water quality in the (mostly culverted) water courses may well be less than satisfactory, data is not available to confirm or deny this. Since they are not classed as 'main rivers' by the Environment Agency, they are not monitored under the Water Framework Directive.

[37] https://www.unitedutilities.com/services/your-water-supply/drinking-water-quality/

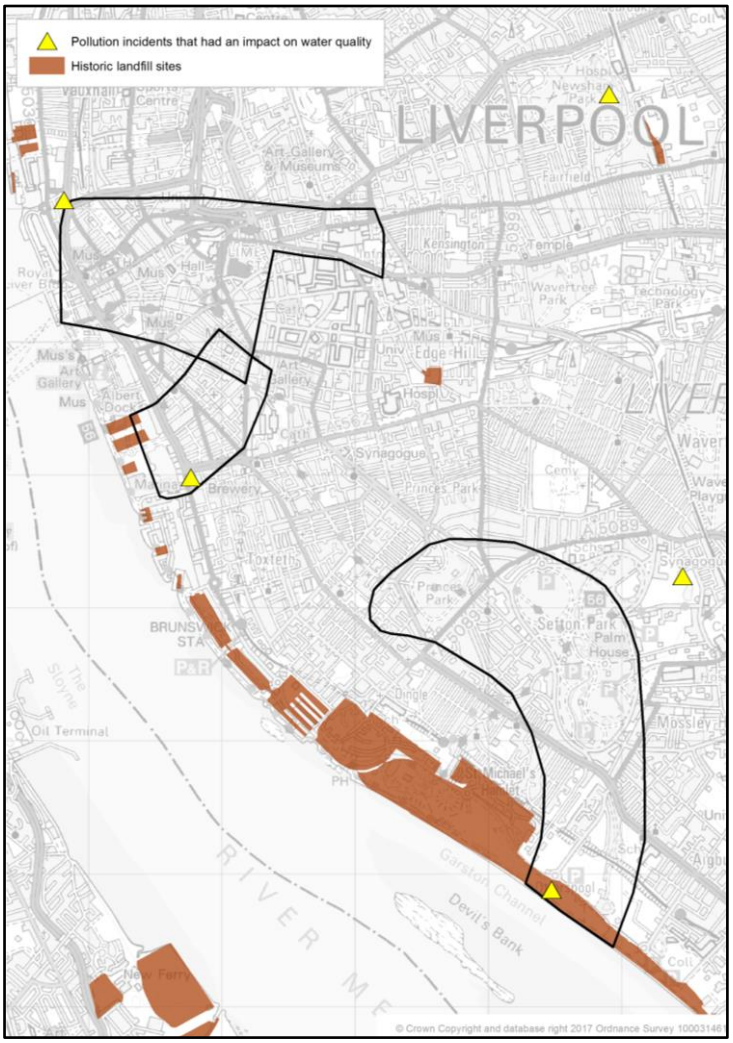


Figure 44: Environment Agency information on incidents and sites that may have an impact on water quality

Reasons to suppose that the water courses in the sub-demo areas might be polluted include the density of the road network nearby and upstream, including many main roads, which is likely to result in polluted runoff. There have also been some pollution incidents logged by the Environment Agency (***Figure 44***)that have had an impact on water quality, but the one marked on the map upstream of the sub-demo areas occurred in 2010, so the water quality may have long since recovered. The historic landfill sites are mostly downstream of the sub-demo areas and are therefore unlikely to have much impact.

A Liverpool City Council study of lakes in parks[38] has produced some useful information. One of the lakes that were assessed is in the Jericho sub-demo area (Princes Park), and another is nearby (Greenbank Park). In both cases the water quality analysis gave no reason for concern, but the fish stock was found to be impoverished and the hydro-soil Biological Oxygen Demand was found to be very poor. A variety of remediation options were suggested.

[38] A.G.A. Group Consultancy, November 2016 - March 2017, Liverpool Park Lakes: Water Management

3.3 Green space management

Challenge 3 Eklipse Framework measures

Challenge 3 Green Space Management	Improved perception of green space, alternative delivery models for managing and funding greenspace.

Key issues to consider

Use of NBS to:

- Help to develop new mechanisms for managing and funding green infrastructure.
- Support the needs of an increased number of older people in our towns and cities.
- Increase awareness of the role that natural environment plays in delivering benefits for the individuals and communities.

3.3.1 Improved perception of greenspace

There are no known assessments of people's perception of greenspace for Liverpool.

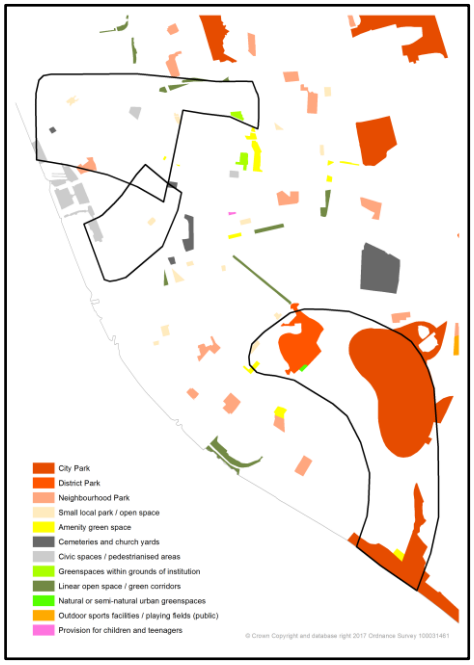


Figure 45: Publicly accessible greenspace

Taken collectively the parks in the Jericho sub-demo area together mean that there is a lot of publicly accessible greenspace there, whereas by contrast, the other two sub-demo areas, which are closer to the urban city centre, have very little publicly accessible greenspace.

3.3.2 Alternative delivery models

The work carried out by the Liverpool Green Space Review Board was detailed in the Diagnosis Report for the city. There are no particular issues that are found in the demonstration areas that are not covered by the work at city level.

3.4 Air Quality

Challenge 4 Eklipse Framework measures

Challenge 4 Air Quality	Reduce air pollution

Reducing air pollution

Key issues to consider

Use of NBS to:

- Improve air quality in target areas.
- Maximise the efficacy of GI interventions to disperse, dilute and deposit substances, which at their present concentrations, contribute to poor air pollution. Dispersion, dilution and deposition are the main mechanisms to reduce harmful concentrations of particulates, oxides of nitrogen, carbon and sulphur along with other substances.

Liverpool City Council has declared the whole city an Air Quality Management Area, suggesting that air quality is generally poor.

Spatial variation within the city can be investigated using the Merseyside Atmospheric Emissions Inventory, which models the expected concentrations of pollutants in different locations based upon traffic data from the Department for Transport, emissions per vehicle data from Defra, industrial emissions data from the Environment Agency and local authorities, weather data from the Met Office, and a variety of other inputs. Maps from the Inventory of NOx and PM10 concentrations are currently being constructed.

Some caveats do apply to these maps. The data is modelled, not measured, and depending upon the availability of monitoring data it may not be possible to validate it – or validation may suggest errors. Also, some of the input data is not completely up to date. Notably, the traffic data is from 2015.

3.5 Urban Regeneration

Liverpool has seen significant regeneration investment over the past 35 years, including over €1bn of EU funding, since 1994.

Key issues to consider

Use of NBS to:

- Work closely with businesses to promote understanding of green infrastructure in helping to improve quality of place, tackle issues such as flood risk, air quality and UHI to improve investability and returns from investment.
- Target key gateways, which are the first impression of the city for many visitors.
- Develop GI Val as a toolkit that can support investment in green infrastructure to support regeneration.

The description of the demonstration areas provided in Section 2 above provides a great deal of information about the plans for regeneration. A multi-billion-pound programme of investment is underway in the city and in the demonstration areas in particular. This provides an ideal opportunity to integrate NBS as part of the wider regeneration of the city.

3.6 Health

Challenge 9 Eklipse Framework measures

Challenge 9 Public Health and Well-being	Increase physical activity, improve wellbeing

Improve Public Health and Well-being

Key issues to consider

Use of NBS to:

- Increase physical activity.
- Improve wellbeing.

3.6.1 Increase physical activity

In Liverpool, the scale of economic deprivation in parts of the city has substantial effects on social factors, including significant health inequalities. Poor living, social, economic and environmental circumstances have impacted adversely on physical health and mental well-being on communities within the city.

Liverpool's Physical Activity and Sport Strategy[39] sets the context for programmes and activity to enable 118,000 (30%) more people to sustain a physically active lifestyle in Liverpool through sport and active recreation by 2022.

As shown in the Diagnosis report, there is evidence to show that green infrastructure can help to support more active lifestyles and reduce health inequalities.

In the demonstration areas, in general the levels of obesity for both children and adults and the incidence of coronary heart disease are not high. However, this does not take into account the high number of people who work in the city from surrounding parts of the city where heath statistics are much worse.

The Physical Activity and Sports Strategy also set an ambitious goal that requires a general increase in physical activity, not just an increase by those who are in poor health.

[39] file:///C:/Users/paul/ShareFile/Shared%20Folders/Liverpool%20GI%20Strategy%20data/liverpool-active-city-pas-strategy.pdf (accessed 27th August 2017)

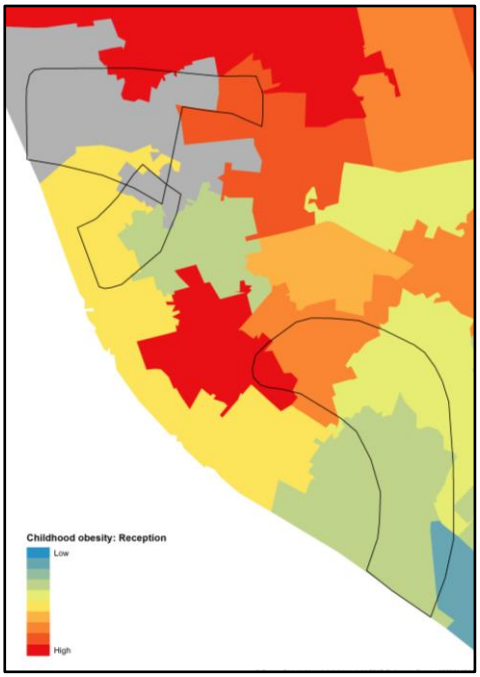


Figure 46: Childhood obesity levels at Reception (age 4-5)

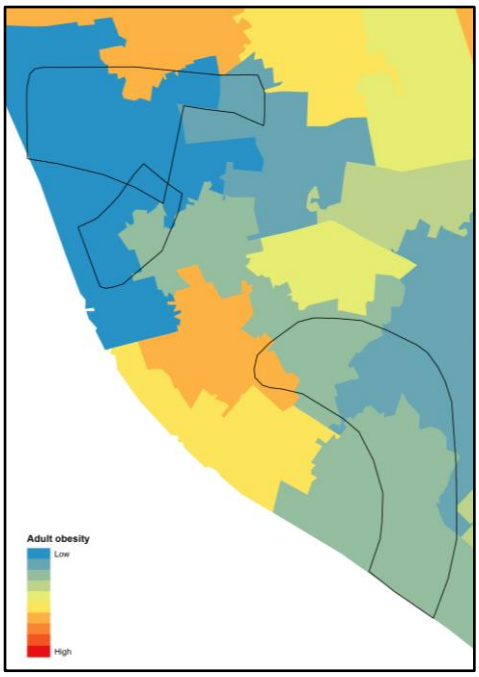


Figure 47: Adult obesity levels

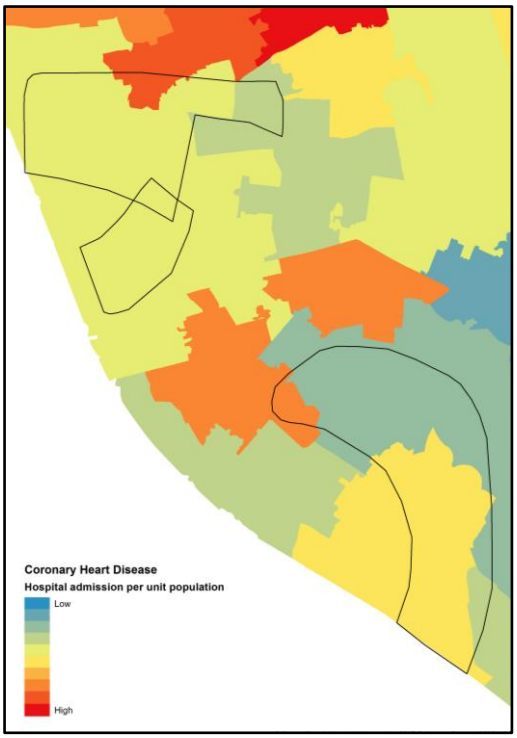


Figure 48: Prevalence of obesity in adults and children, and hospital admissions for coronary heart disease per unit population

Whilst levels of adult obesity near the sub-demo areas were fairly low in 2003-5 (when the data was collected), levels of childhood obesity in 2012/13 to 2014/15 were generally high. There were many hospital admissions for coronary heart disease nearby in 2007-8, especially north of the City Centre sub-demo area.

3.6.2 Mental health and wellbeing

Common mental health problems are estimated to affect a quarter of Liverpool's population at any one time. Estimates produced by the Mental Health Observatory in 2008 suggest Liverpool experiences the second highest prevalence of common mental illness in England, with over 93,000 people affected[40].

There are clear links between physical activity and mental health.

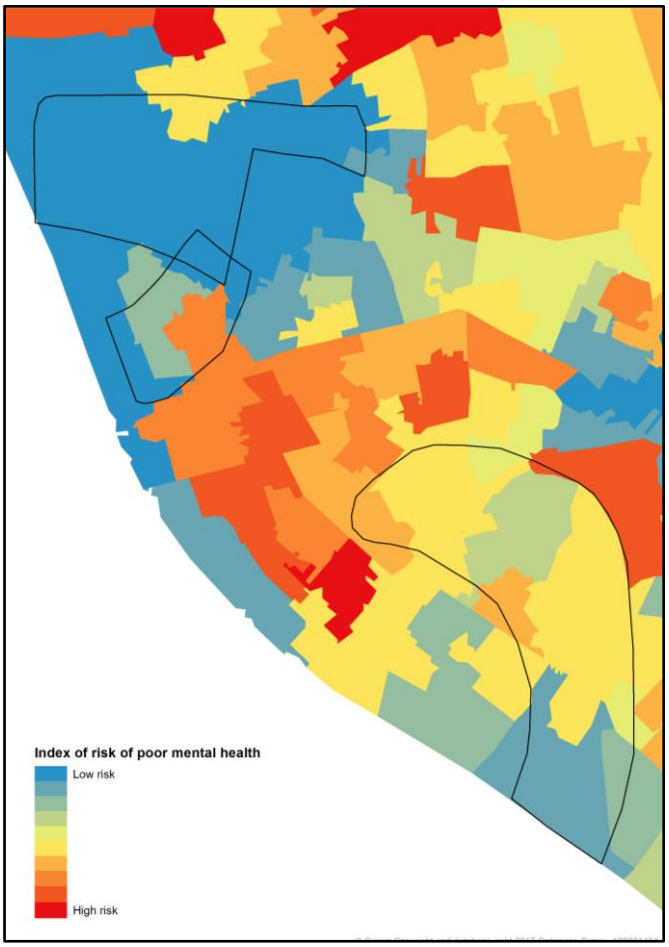


Figure 49: Index of risk of poor mental health

Data on reported mental health is unfortunately not available to the level of spatial detail required here, so instead an index has been constructed from factors that have been shown to increase the risk of poor mental health[41]. A high level of risk exists in several neighbourhoods near the sub-demo areas.

The population of students in Liverpool is high and many students live in the demonstration areas. There is concern about the increasing levels of poor mental health amongst students. A

[40] JSNA - http://liverpool.gov.uk/media/9738/adultsolderpeoplementalhealth.pdf (accessed 11th August 2017)

[41] Moscone, F, Knapp, M and Tosetti, E, Mental Health Expenditure in England: A Spatial Panel Approach (2006). Available at SSRN: https://ssrn.com/abstract=898474 or http://dx.doi.org/10.2139/ssrn.898474

recent National Union of Students (NUS) survey indicates that 20% of students experience mental health problems but, of these, only 36% seek formal advice or support. The problems relate to coursework deadlines (65%), exams (54%), financial difficulties (47%), pressures about "fitting in" (27%) and homesickness (22%). Stress is the most common symptom (80%), with many students also reporting a lack of energy or motivation (70%), anxiety (55%), insomnia (50%) and panic (38%). 14% consider self-harm and 13% report suicidal thoughts.[42]

Provision of local green infrastructure can assist in maintaining a healthy population, by encouraging exercise and ameliorating mental health. Liverpool's JSNA includes the health benefits of green infrastructure[43].

3.6.3 Natural Health Service

The Natural Health Service has been developed by a consortium of organisations including the Liverpool Universities, to develop products with a strong evidence base that use the natural environment as a location for health programmes that increase physical activity and improve wellbeing[44].

Results from delivery of the Natural Health Service over the past two years show increases in both physical activity and wellbeing. This data is based on over 1500 participants in nature based programmes, one of the largest datasets available for this type of intervention.

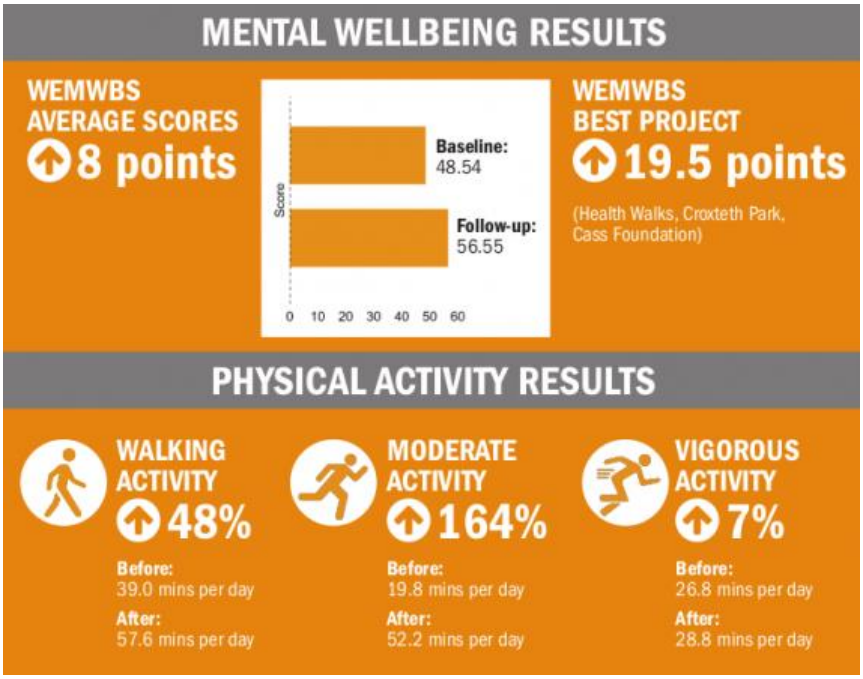


Figure 50: Natural Health Service result

[42] Brown, Poppy. "The invisible problem? Improving students' mental health." *Higher Education Policy Institute (HEPI)* (2016).
[43] http://liverpool.gov.uk/media/9123/jsna-statement-of-need-update-2014-v2-1.pdf (accessed 17th August 2017)
[44] http://naturalhealthservice.org.uk/wordpress/ (accessed 17th August 2017)

3.6.4 Children's health and wellbeing

There is a strong focus on improving the health and wellbeing of young people in the city. Engaging schools and integrating NBS to encourage physical activity and enhance well-being is an important consideration for any programme aimed at young people and their families.

However, we have identified that there are few schools in the demonstration areas (see ***Figure 51***). We have extended the demonstration areas to include schools that are in close proximity and plan to operate an extensive programme with some of these schools to improve health and well-being and promote awareness of the natural environment and connectedness to nature.

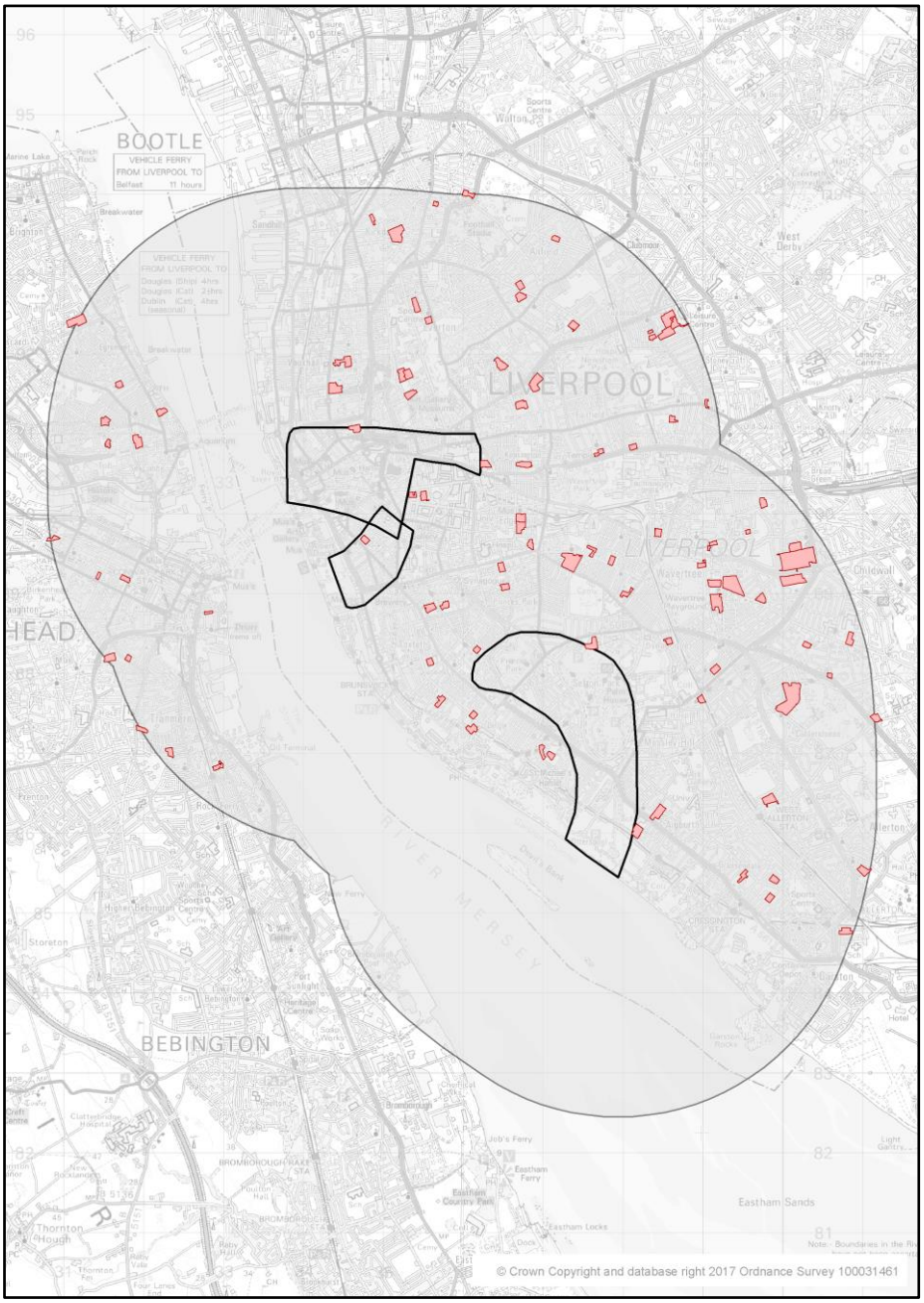


Figure 51: schools in the vicinity of the demonstration areas

3.7 Planning and governance

The city of Liverpool has engaged directly with the management of its physical environment working with partners to ensure that the city's water bodies, parks and open spaces are of high quality. This requires a collaborative approach to evidence-based planning and decision-making that draws on the public, private and third sector involvement. The creation of the city's Local Plan and Local Development Framework highlight this process, as does the development of the city's Green Infrastructure Strategy and Green & Open Space Review.

3.7.1 Planning

England's planning system is centralised, with the National Planning Policy Framework (NPPF)[45] setting clear expectations for both strategic and local development. The English system is statutory requiring local authorities to develop policies which reflect the existing condition of a city, and to identify where investment in strategic and locally significant development should occur. At a local level, Local Plans are used to frame development and are produced by Local Authorities in consultation with local stakeholders.

Key issues to consider

Use of NBS to:

- Inform development of plans and strategies for the city and city region.

Liverpool City Council is currently consulting on its Liverpool Local Plan 2017, which is aligned with the NPPF and supported by the Sustainable Urban Development Strategy, Liverpool City Region, 2015 and Liverpool City Centre Strategic Investment Framework, Liverpool Vision. The requirement to produce a Local Plan is set out within the NPPF. On the 19th August 2016 Liverpool City Council's Cabinet approved the undertaking of public consultations on the draft Liverpool Local Plan, which is intended to both update and amend the city's existing planning framework, the Unitary Development Plan and will seek to focus on delivering homes in brownfield sites, protecting land and buildings for economic growth and protect Liverpool City's parks for the health and wellbeing of the population. Using the information produced through the Strategic Green & Open Space Review and the forthcoming Open Space Review, as its evidence base the final version of the Local Plan will give direction on the future provision of accessible high quality sustainable provision for green infrastructure and NBS across Liverpool based on population, distribution, planned growth and consultation findings.

The Local Plan is due to be completed in 2017 but in the interim the draft Local Plan contains proposed policies that take on board the Open Space and Green Wedge policies in the existing UDP as well as new policies to address the natural environment. The Emerging Local Plan is also underpinned by an earlier Local Plan Sustainability Appraisal in 2014 which included Strategic Environmental Assessment, Habitat Report Assessment and an Equality Impact

[45] National Planning Policy Framework, Ministry of Housing, Communities and Local Government, 2012

Assessment. The Local Plan discussions are supported by the Liverpool's Sustainable Development Plan which guides the council's performance framework, corporate strategies and individual service plans, helping to put sustainability at the heart of what Liverpool City Council thinks and does. As sustainability means generating a better quality of life, whilst improving local environmental conditions for local people and future generations for Liverpool City Council this means always challenging the way things are done and providing leadership for the whole community.

There are no Area Action Plans or similar documents linked to the Local Plan planned for the demonstration areas. However, there are a number of strategies that will have some influence on how these areas will be developed over the coming years. Incorporating green infrastructure policy, linking to the Local Plan, will help to enable NBS delivery in these areas. Urban GreenUP can help to provide demonstrations of how NBS can help to tackle some of the issues found in the demonstration areas (as set out this document and in the Diagnosis).

Table 9: Key Regeneration documents for each demonstration area

Demonstration Area	Key documents
Baltic Corridor	Baltic Regen Strategy. Liverpool Greenspace Review,
City Centre BID	BID Business Plan, Site Development Plans (Temple Sq., Ropewalks,)
Jericho Lane	

3.7.2 Government

Liverpool city council's approach to governance of its green spaces is set out in its Green Space Review. Policy on wider green infrastructure is set out in the Local Plan. At a neighbourhood level, there is an increasing amount of community stewardship of green spaces. This is partly driven by funding cuts meaning that there is less capacity in the local authority to manage sites and partly comes from community interest and empowerment.

Key issues to consider

Use of NBS to:

- Influence policy and strategy in the city, city region and nationally.
- Highlight opportunities of NBS to the new City Region.

The city council comprises 90 councillors from elected from 30 wards. The ward is the primary unit of English electoral geography for councils in England. Each ward/division has an average electorate of about 5,500, but this can vary significantly and is obviously affected by the cycle of growth, decline and regeneration seen in many cities.

The demonstration areas are covered by nine wards, some with only a very slight overlap some with a significant amount of the ward in the demonstration area.

Table 10: Liverpool Wards in each Demonstration area

Sub-demo area	Ward	Percentage of ward area covered
The Baltic Corridor	Riverside	19.69%
City Centre Retrofit	Central	53.38%
City Centre Retrofit	Everton	2.70%
City Centre Retrofit	Kensington and Fairfield	0.01%
City Centre Retrofit	Kirkdale	0.09%
City Centre Retrofit	Riverside	5.35%
Jericho SUDS	Greenbank	4.58%
Jericho SUDS	Mossley Hill	25.05%
Jericho SUDS	Princes Park	19.57%
Jericho SUDS	St Michael's	50.02%

Engaging elected representatives from these wards in the delivery of the Urban GreenUP can help to influence policy and strategy development in the city.

With the advent of the new Metro Mayor, with a city region mandate, there is also an opportunity to highlight the opportunities for NBS at the city region level. Work is already underway to engage the city region Mayor in the delivery of the wider Green Infrastructure Framework for the City Region.

3.8 Social justice and social cohesion

Social justice recognises that society comprises of a diverse set of social groups, with varying requirements, rights and duties that need mutual support, co-operation and acceptance[46]. In green infrastructure planning, most attention has been devoted to environmental justice, which includes the promotion of an equitable process of development and access, elements of distribution, procedure and recognition[47]. Distributional justice relates to the unequal distribution, both social and spatial, of environmental qualities[48].

Levels of green infrastructure in the Baltic Corridor and City Centre BID areas are both low and much lower than both other parts of the city and compared to other city centres. Jericho Lane has much higher levels of green infrastructure.

The Liverpool Green Infrastructure Strategy highlighted the fact that lower levels of green infrastructure were most often associated with higher levels of deprivation. This is borne out by the data from our demonstration areas too, with the lower levels of green infrastructure found in the areas with issues, such as child poverty and lower average income, associated with deprivation.

46 Zajda, J. et al. (2007): Introduction: Education and social justice. International Review of Education, 52(1), 9- 22.
47 Rutt, RL. & Gulsrud, NM. (2016) Green justice in the city: A new agenda for urban green space research in Europe. Urban Forestry & Urban Greening, 19, 123-127.
48 Perez, AC, Grafton, B, Mohai, P, Hardin, R, Hintzen, K. & Orvis, S. (2015) evolution of the environmental justice movement: activism, formalization and differentiation. Environmental Research Letters, 10, doi:10.1088/1748-9326/10/10/105002

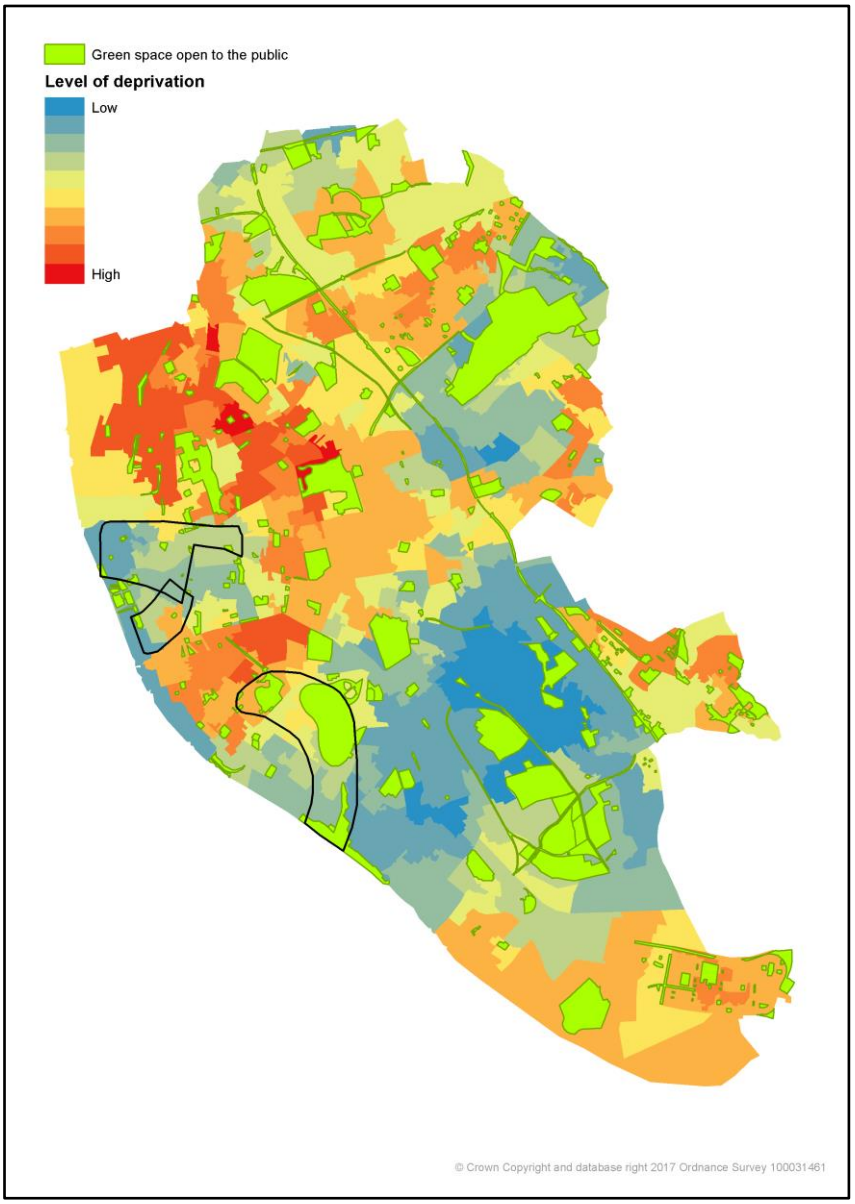


Figure 52: Deprivation and accessible green spaces in Liverpool

Key issues to consider

Use of NBS to:

- Engage communities and support work to improve areas of greenspace in areas of low provision.

3.9 Economic opportunities and green jobs

There is no easy way to identify the numbers of jobs associated with green infrastructure planning, delivery, management and usage for Liverpool. Work at the sub regional level by Regeneris[49] attempted to identify both the scale of the green infrastructure sector and estimate the likely increases in 'green' jobs based on increased investment in green infrastructure projects and programmes. Using data from NOMIS, they estimated that there were approximately 8,000 jobs in the city-region related to green infrastructure, generating over £300m of GVA/annum. The report also projected that a proposed programme of £36m in investment, with a focus on skills development and apprenticeships, could create 2000 new jobs in the city-region. In addition to these projections Liverpool's Green Infrastructure Strategy used version 1.0 of the Green Infrastructure Valuation Toolkit to assess the economic value of the existing landscape resource in the city. This identified that the parks, woodlands, gardens, rivers and wetlands collectively provided over £8bn of economic benefits for the city.

Green infrastructure can also play a major role in attracting investment. Surveys have shown that green infrastructure adds value to commercial property. 95% of property developers would be willing to pay at least 3% more to be near open space[50]. Coupled with this, 98% of people believe that trees and green spaces can improve the appearance of a town and have been found to increase land and property prices by 7-18%[51].

Key issues to consider

Use of NBS to:

- Support new jobs and businesses.
- Develop a GI sector that can argue for support for the sector
- Attract investment by improving quality of place.

The numbers of jobs created directly as a result of the Urban GreenUP interventions will be monitored as will the impact on employment in the areas within which the interventions are made. However, disentangling the effects macro as well as other micro level impacts from the Urban GreenUP investments will be challenging.

[49] GI and Jobs – Report to The Mersey Forest, available from Mersey Forest Team

[50] Gensler and Urban Land Institute (2011) Open Space: an asset without a champion? Available at: http://www.gensler.com/uploads/documents/Open_Space_03_08_2011.pdf

[51] CLES POLICY ADVICE. 2007. The Contribution of the Local Environment to the Local Economy presented to Groundwork UK.

3.10 Urban regeneration

Liverpool has seen significant regeneration investment over the past 35 years, with €1bn of EU funding supporting regeneration since 1994.

Regeneration of the city is accelerating. Liverpool is undergoing a £13bn regeneration led renaissance. Large scale regeneration of the Liverpool waterfront, a new creative district and the development of world-leading knowledge sector, supported by Liverpool's Universities, are all underway. Over £3bn has been invested in the City Centre Economic Development Zone alone in the past 5 years.

In the next five years Liverpool will deliver of 10,000 new homes, Everton FC's new stadium, a new cruise terminal, a new TV and Film hub, £250m of road infrastructure and 2 million sq. ft. of commercial office space. Liverpool is ideally positioned on Britain's Atlantic-facing coastline it is the gateway to the Northern Powerhouse, a focal point for a city region with a GVA of £30bn per annum.

Many regeneration schemes have affected the sub-demo areas, are affecting them, and will affect them in the future, especially the City Centre and Baltic Corridor areas. Current and imminent schemes[52] include:

- Liverpool Knowledge Quarter
- Northern Gateway
- North Eastern Corridor
- Stanley Dock Complex
- Ten Streets
- South Eastern Corridor
- City Fringe
- Festival Park
- Princes Avenue
- Great Howard Street
- Liverpool City Centre Connectivity Scheme
- Park Lane
- Commercial District BID
- City Central BID
- A57
- Netherfield Road South
- Earle Road

Together, these are likely to profoundly alter the form of the city centre, and offer many opportunities for green infrastructure interventions.

[52] http://liverpool.gov.uk/business/regenerating-liverpool/

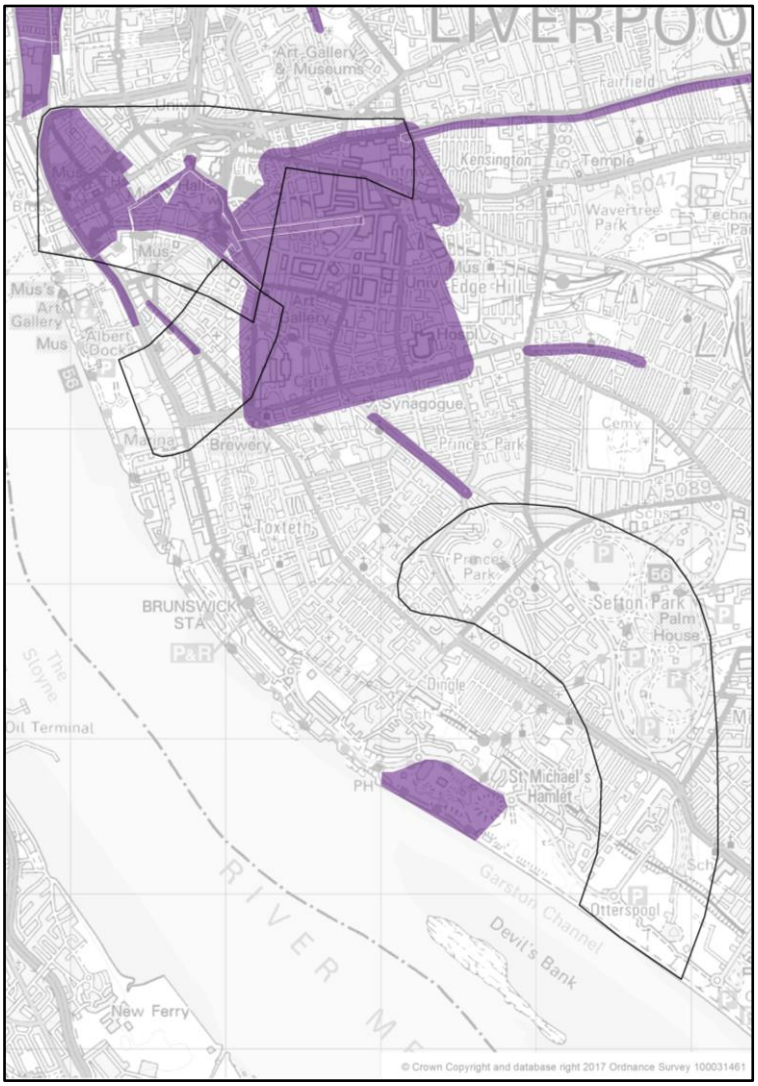


Figure 53: Regeneration schemes

3.11 Biodiversity

Eklipse Framework

Biodiversity	More, bigger, better managed and well-connected habitats. Enhancing ecological networks.

3.11.1 Enhancing ecological networks

The Ecological Framework for Liverpool[53] sets out many of the key biodiversity issues for the city. The framework should influence the Local Plan and contribute toward the delivery of biodiversity and green infrastructure plans.

Key issues to consider

Use of NBS to:

- Increase biodiversity in the city.
- Improve connections to neighbouring areas.
- Increase awareness of the importance of biodiversity in the city.

The Baltic Corridor and City Centre areas have very low levels of green infrastructure and limited opportunities for biodiversity at present. The planned interventions in the demonstration areas can add significantly to the amount of green infrastructure in these locations and provide greater connectivity of habitat both within the demonstration areas and with the wider city. Although there is limited data on biodiversity in the city it is recognised that the Jericho Lane/Otterspool demonstration area has higher levels of green infrastructure and biodiversity.

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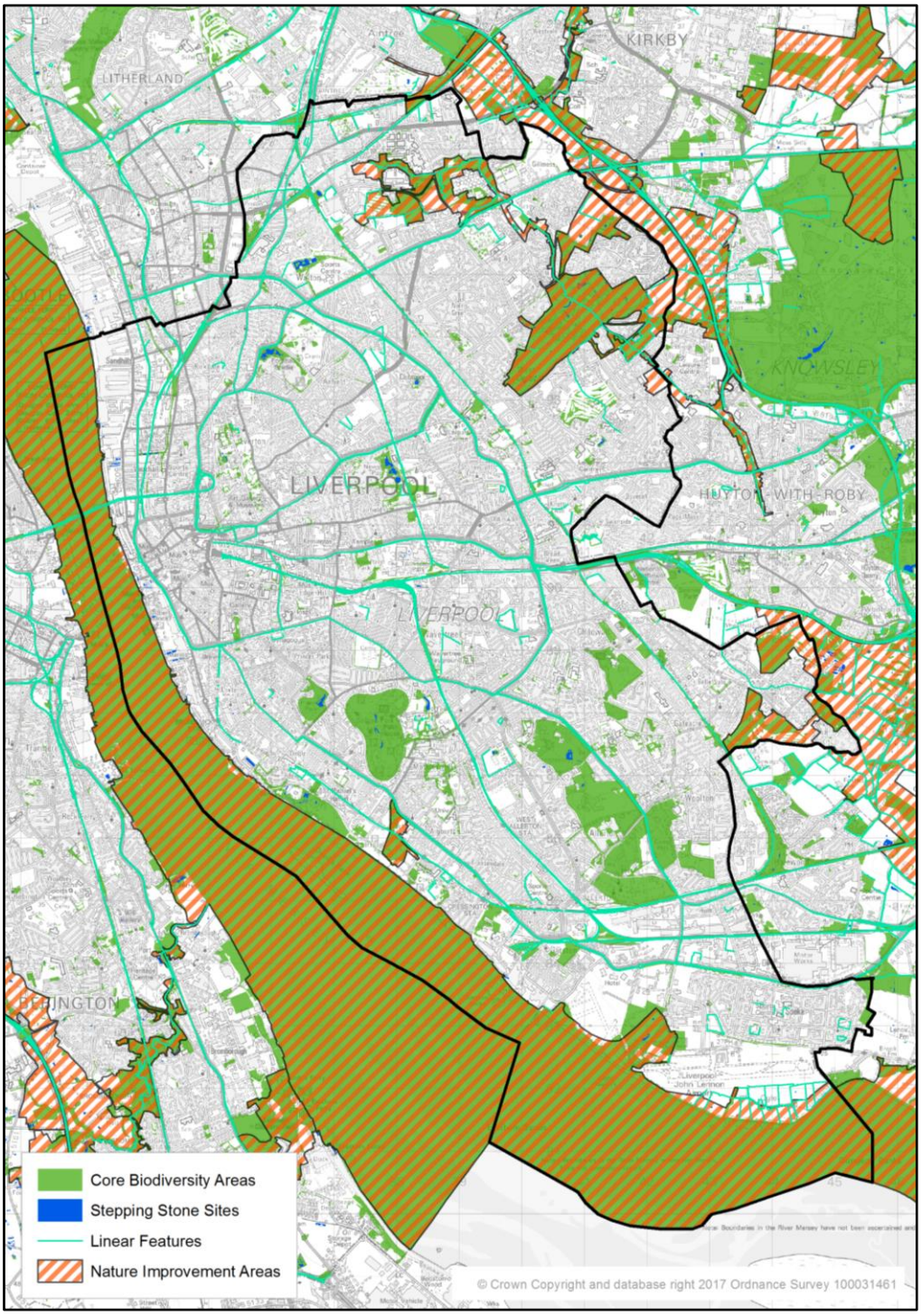

Figure 54: Core Biodiversity Areas

The Jericho Lane demonstration area has large areas within Liverpool's ecological network, with some linear features in the other two demonstration areas. To the west of the city, the river Mersey has been put forward as a Nature Improvement area. Work within the demonstration areas to improve water quality can help to safeguard this valuable habitat and asset for the city.

3.12 Combining the issues

For each of the issues above, for which maps were able to be produced, locations were identified where the issue is particularly severe, and these were combined to give ***Figure 55***. This shows that there are most issues in the City Centre sub-demo area, followed by the Baltic Corridor, with the Jericho/Otterspool sub-demo area having the fewest issues.

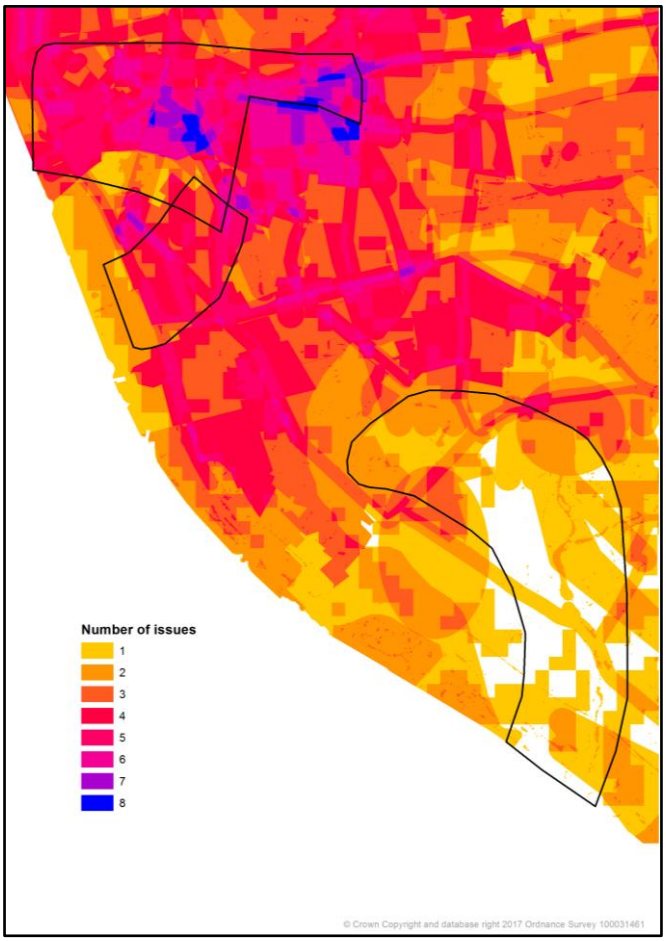

Figure 55: The number of issues that are particularly severe in each location

Figure 55 does not weigh any of the issues present in the demonstration areas, simply providing a count of the issues.

A key requirement for NBS intervention is to tackle multiple issues where possible. This will be taken forward in the technical specification strand of the Work Package 3.

4 Description of the Interventions for each Demonstration Area

Having identified the key issues for NBS in each of the demonstration areas, a number of interventions to address these issues have been identified. These interventions are based on a sound evidence base, provided in Urban GreenUP 3.1.

Table 11: Description of Liverpool NBS interventions

Intervention	Function
Urban Catchment Forestry	Engineered solutions to retrofit sustainable tree cover in urban areas to reduce flood risk and improve water quality. Incorporating best practice in: nutrient releasing soil technologies, urban drainage techniques and an ecological approach to species selection for location.
Wood Allotments	An initiative to involve volunteer labour in managing young woodland, providing wood fuel for participants, ensuring woodland thinning operations are carried out at little cost, community connectivity to woodlands and improved community cohesion. Promotes understanding of the value of local Green Infrastructure.
Pollinator verges and spaces	Areas of grassland close to highways or on neglected land that are sown with wildflowers and ecologically chosen species to encourage pollinating insects, increase biodiversity and create a sense of place and social cohesion
Pollinator walls/vertical	Building living pollinator walls in urban areas decreases the urban heat island effect and provides pollinators a safe place to feed, rest and thrive. Pollinator walls and other verticals will seek to create green infrastructure in tight spaces dominated by hard urban landscapes.
Pollinator roofs	Green roofs designed to provide maximum benefit for bees and other pollinators whilst also functioning to manage water flows and provide cooling. The option of renewable energy production was not progressed within Urban GreenUP due to the city centre location and size of the available roofs within the demo areas, and acceptability to property owners. The pollinator roof is a social space above a theatre. The green roof trial will enable the direct engagement of commercial businesses in testing the value of green infrastructure.
Shade trees	Trees positioned in strategic locations to maximise summertime shading. Species selected will be broad-leaved trees with spreading canopies to maximise shade in summer, reducing thermal loading on buildings, but with an open canopy in winter to allow for passive solar loading.

Intervention	Function
Cooling trees	Trees planted to take advantage of evapotranspirative cooling. Species selected will be those which transpire at high rates to maximise their cooling effect. Provision of a constant water supply to such trees will be essential to ensure this function is effective.
SuDS	Sustainable Drainage Systems will be implemented to replicate natural systems that use cost effective solutions with low environmental impact to drain away dirty and surface water run-off through collection, storage, and cleaning before allowing it to be released slowly back into the environment.
Cycle Route Definition	Cycle route definition will introduce innovative ways of establishing green cycle routes where harder engineering solutions are not feasible.
Green Travel Routes	Enhancements to active travel routes designed to make them more attractive and encourage greater use.
Pollution Filters	Densely planted trees, hedging or other vegetation that creates a physical barrier to intercept or trap fine particulate pollutants in urban areas.
Carbon Capture	Interventions designed to maximise and test carbon sequestration through growth of woody plants, shrubs and trees.
GI for Physical Activity	Green Infrastructure interventions specifically aimed at encouraging outdoor physical activity, creating places where “Health is a Natural Choice”.
GI for Mental Health	Green Infrastructure interventions designed to provide a setting which promotes improved mental health and/or provides a setting for nature based activity to maintain good mental health and develop new coping strategies for mental health issues for people living and working in an urban location.
Forest School	Forest School is an innovative, self-led learning approach adaptable for all age groups in a woodland setting, supported by a trained Forest School Leader, linking to delivery of national curriculum and wider health and social benefits for children and teachers.
Forest Church	The Forest School concept will be extended in a unique trial to work across age groups with the community engaged within the local church.

Intervention	Function
Green Art/engagement	To test the impacts of degrees of engagement in GI and developing a sense of place across different communities. Local people will be facilitated to work with others outside their immediate community and with artists to create local works of art that reinforce a GI theme and seek to embed a sense of place
GI for Education	Promoting the understanding of GI in urban areas through active engagement with schools and community groups. Proving opportunities to see the existing GI, help plan the new interventions, participate in greening the city and caring for greenery in the city. The intervention will include site visits, exhibitions, consultation and talks/seminars.
Rain garden	A planted depression or hole that allows rainwater runoff from impervious urban areas, like roofs, driveways, walkways, parking lots, and compacted lawn areas, the opportunity to be absorbed.
Temporary or floating green infrastructure	Trees and/or other green infrastructure which are both self-contained and mobile and can be located or positioned in a variety of urban, open or blue spaces for maximum effect and impact.
Smart Soils	The use of biochar to increase the absorption of water pollutants from urban run-off and slow release of plant nutrients will be tested to improve the functionality of soils in the city. Smart soils will be used in tree pits and to enhance biodiversity.

4.1 Sub-Demo A - Baltic Corridor Green Links

As a former industrial area the Baltic Triangle has repurposed a significant proportion of its built infrastructure, however, there remains a clear deficiency in the quality and quantity of its green and open space. Street trees offer a range of socio-economic and ecological benefits and have some of the highest impacts in terms of visible urban greening. The planting of street trees will aim to address on-street surface water flooding, offer pollutant capture and increase the habitat and biodiversity provision in the area.

In addition to the installation of street trees an extended network of permanent/temporary local green spaces will be developed to improve the connectivity and multi-functionality of the area. This will draw on existing sites, as well as meanwhile spaces to form a series of links, hubs and nodes across the area. The aim of this intervention is to evaluate how urban-environmental systems can be developed in post-industrial landscapes to improve biodiversity and social interactions with urban spaces. The network will linkup existing social spaces, such as schools or community centres, with homes and businesses to promote greater fluidity of use and functionality of the Baltic area.

Raising awareness of environmental issues with young people is a key incentive of urban greening interventions within the Baltic area. Local school/s will be engaged to adapt spaces for biodiversity and functionality monitoring. The project will work with schools to highlight the values that interactions with local green spaces can provide for children's educational attainment, health and well-being.

Using citizen science techniques local school children will conduct site surveys of the biodiversity and/or functionality of the green and open spaces in the Baltic area. This will be fed back into a larger database for the area to illustrate existing and changing species/ecology in the area.

To maximise the high proportion of built infrastructure in the City Centre a network of 'green' walls and roofs are proposed to provide an ecological and aesthetic enhancement for the area. This will make use of varied species selections and techniques to test the viability of different approaches to vertical greening in urban areas. Working with a selection of stakeholders (including developers) the green walls and roofs will raise environmental awareness of the value of urban greening, and promote a more in-depth understanding on the ecological value green infrastructure in compact urban areas.

Monitoring will include assessments of the uptake and development of the vertical greening sites and the influence they have on local climatic variation. This will include the use of data sensors, as well as observational analysis. To ensure 'buy-in' is created the businesses/landowners of the sites will be engaged/surveyed to assess their understanding of the added-value that urban greening can generate economically

To facilitate community engagement with new urban greening a citizen science and data platform will be developed to allow people/stakeholders to input and share media/big data about biodiversity, landscape quality and functionality. The media/data platform will be linked to sensor data to give people a 'real-time' understanding of the benefits that urban greening can deliver climatically and socially.

Table 12: Challenges to be addressed in Baltic Corridor

Sub-Demo A - Challenges to be solved	Achieve:
Heat Island Effect	
Disconnection among urban green areas	✓
Poor soils quality/activity (contaminated, sealing, and poor soils)	
Loss of biodiversity	✓
Derelict urban areas	✓
Social issues	✓
Aquatic spaces deteriorated	

Non-environmentally or economically sustainable urban green areas	✓
Flood risk	✓

It is proposed to design GI interventions that break down barriers by, the innovative introduction of GI to both to remove actual barriers but also to alter the perceptions of barriers and provide a visual cohesion of urban form and theme linking through four communities. These communities include: a student area; existing local residential community, (including school and religious communities; through a burgeoning creative industries community of workers; and finally to a key visitor destination. Plans for this work include developing local community engagement with an improved quality of Green Infrastructure through the development of local food or horticultural growing initiatives, or using green art to change perceptions. Work will also be carried out to engage local developers to manage and maintain green walls and other infrastructure and engaging local creative industries to develop local biodiversity engagement tools.

Table 13: Interventions and budget for Baltic Corridor

INTERVENTION	Baltic Projected Costs	Baltic EU Funds
Urban Catchment Forestry (no.)	€ 159,390	€ 159,390
Pollinator verges (m2)	€ 136,620	€ 136,620
Pollinator walls/vertical Type A (m2)	€ 91,080	€ 91,080
Cooling trees (no.)	€ 94,875	€ 94,875
SuDS Type B (m3)	€ 607,200	€ 607,200
cycle route definition (m)	€ 91,080	€ 52,726
Forest School (no.)	€ 12,903	€ 0
Forest Church (no.)	€ 12,903	€ 0
Green Art/engagement (no.)	€ 30,360	€ 30,360
GI for education (no.)	€ 9,108	€ 0
Floating gardens (no.)	€ 79,200	€ 79,200

BioApp community engagement (no.)	€ 22,400	€ 22,400

Liverpool City Council is the partner in charge of the specification and installation. Baseline monitoring will be established for all of the identified impacts below:

4.2 Sub-Demo B - City Centre Business Improvement District

Brief Description:

The City Centre of Liverpool is one of the worst resourced neighbourhoods of the city for green space. Whilst is has high quality parks at its periphery, a significant proportion of the area lacks any form of urban greening. Urban design has therefore taken precedence over the landscape aesthetic of the area. The City Centre is also constrained by its density and the limited availability for green space development. Therefore, although the area is the economic hub of the city it lacks a level of quality and functionality to its environment. The City Centre GI work programme will address this deficiency through a series multi-scaled green infrastructure interventions.

To maximise the high proportion of built infrastructure in the City Centre a network of 'vertical gardens' are proposed to provide an ecological and aesthetic corridor running through the area. This will make use of varied species selections and techniques to test the viability of different approaches to vertical greening in urban areas. Working with a selection of stakeholders (and the BID) the vertical gardens will raise environmental awareness of the value of urban greening, and promote a more in-depth understanding on the ecological value green infrastructure in compact urban areas.

Monitoring will include assessments of the uptake and development of the vertical greening sites and the influence they have on local climatic variation. This will include the use of data sensors, as well as observational analysis. To ensure 'buy-in' is created the businesses/landowners of the sites will be engaged/surveyed to assess their understanding of the added-value that urban greening can generate economically

Increasing the awareness of landscape functionality is key to generating longer-term engagement with the landscape. To achieve this, a series of 'moving/temporary gardens' are proposed for the City Centre of Liverpool (Church Street and Paradise Street) that will pilot the use of a variety of alternative planting/species public green space configurations. These will test how alternative planting regimes develop in areas of high foot and evaluate public responses to temporary green infrastructure investments.

Monitoring will be undertaken using social survey techniques to investigate the understanding and value of urban greening in compact urban areas. This will include reflections of likelihood to spend time/money in-situ, as well as the awareness of the public and local businesses of the added-value that urban greening can deliver. It will also use climatic and species monitoring to investigate the resilience and/or evolution of different species in urban areas.

Due to the impermeable surfaces that dominate the City Centre there is scope for greater intervention in drainage and watering scheme techniques to link this location with the Albert Docks and the River Mersey. Moreover, the nature of surface water run-off in the City Centre could be addressed through more effective water management and/or greening.

Table 14: Challenges to be addressed in City Centre BID

City Centre BID - Challenges to be solved	Achieve:
Heat Island Effect	✓
Noise and air pollution	✓
High maintenance costs in green areas	✓
Disconnection among urban green areas	✓
Poor soils quality/activity (contaminated, sealing, and poor soils)	✓
Loss of biodiversity	✓
Derelict urban areas	
Social issues	
Aquatic spaces deteriorated	
Non-environmentally or economically sustainable urban green areas	
Flood risk	✓

Design GI interventions that improve the environmental quality of the city centre commercial spaces by the introduction of vertical GI and roof GI space and mobile gardens are proposed for this sub demo area. It is anticipated that the interventions will provide evidence of both natural and economic GI impacts and facilitate the embedding of positive GI planning in municipality and commercial planning decisions.

Interventions:

NBS implemented in Sub-Demo B

Table 15: Interventions and budget for City Centre BID

INTERVENTION	BID Projected Costs	Baltic EU Funds
Urban Catchment Forestry (no.)	€ 382,536	€ 328,916
Pollinator walls/vertical Type B (m2)	€ 273,544	€ 273,544
Pollinator roofs (m2)	€ 54,648	€ 54,648
Shade trees (no.)	€ 18,975	€ 18,975
Cooling trees (no.)	€ 18,975	€ 18,975
Green Travel Routes (no.)	€ 5,594	€ 5,594
Carbon Capture (ha)	€ 15,180	€ 0
GI for mental health (no.)	€ 22,770	€ 22,770
GI for education (no.)	€ 18,216	€ 0
Moving gardens (no.)	€ 52,800	€ 52,800

The Mersey Forest will lead the specification and installation in this area, working with Liverpool BID and their members along with the City Council.

4.3 Sub-Demo C: Jericho Lane - Sustainable Urban Drainage Solutions

Brief Description:

Linking the city-centre to the southern core of the city is Otterspool promenade one of the city's best used linear corridors. However, along its route are several recent housing developments and amenity green spaces/sports pitches, which are of varying quality. Jericho Lane is the main east-west route in the area and is subject to a number of social, ecological and transport issues. These restrict the areas functionality and in effect isolate areas of the promenade and green spaces from use, thus lowering its socio-economic capacity. To address this, a series of interventions along the transport routes linking into the areas green spaces are proposed.

Jericho Lane/Aigburth Road junction road will be improved through increased accessible paving and a redesigned layout to facilitate movement, especially for younger and older people. The creation of a more user-friendly junction should also improve the physical environment by managing the flow of traffic to regulate traffic, and by extension reduce traffic emissions. Additional urban greening in the form of buffer planting could also be used to provide further moderation of the areas emissions.

Use and access to the sites will be monitored using trip sensors to highlight the changing number of users using the crossing to estimate increased functionality. Additional indicator species could be used to monitor the level of pollution at each junction to evaluate the value of certain species choices.

To ensure that the area's water systems are functional a process of de-culverting is proposed (where feasible) to reinstate the areas waterways. Using SuDS and innovation monitoring a more refined process of water management will be developed to moderate flows and ensure surface water flooding is regulated. This would culminate in a new wetland area that would provide additional habitat for local biodiversity.

Water flow and quality will be monitored to assess change over time pre- and post-investment. Sensors will be used to detect changes in flow and reported to a central database. Additional monitoring will be undertaken to assess the uptake of species richness and health in the wetlands areas to better understand which plants are suitable for the city's climate.

Table 16: Challenges to be addressed in Jericho Lane

Issue to be solved:	Achieve:
Heat Island Effect	
Noise and air pollution	✓
High maintenance costs in green areas	
Disconnection among urban green areas	✓
Poor soils quality/activity (contaminated, sealing, and poor soils)	
Loss of biodiversity	
Derelict urban areas	
Social issues	✓
Aquatic spaces deteriorated	✓
Non-environmentally or economically sustainable urban green areas	✓
Flood risk	✓

The intention at this site is to work with the municipality Highways department to introduce a NBS SUDS solution to long term urban drainage problems, whilst at the same time addressing poor pedestrian and cycling accessibility and connectivity between key green spaces currently cut off by major roads.

The primary element will be the de-culverting of historic drainage channels (where feasible) and the introduction of a natural SUDS in a suburban setting. The research element of this project will also compare design techniques; species introduction and management regimes with 2 existing urban SUDs one perceived as highly successful one less so to enable the production of a standardised tool kit and lessons learnt relevant to many circumstances.

Interventions:

NBS implemented in Jericho Lane.

Table 17: Interventions and budget for Jericho Lane

FACILITY	TOTAL COST (incl. Co-Financing)	EU REQUEST
INTERVENTION	JERICHO Projected Costs	JERICHO EU Funds
Wood Allotments (ha)	€ 11,385	€ 11,385
Pollinator verges (m2)	€ 4,554	€ 4,554
Pollinator walls/vertical Type A (m2)	€ 36,432	€ 36,432
SuDS Type A (m3)	€ 341,550	€ 341,550
Cycle route definition (m)	€ 45,540	€ 45,540
Carbon Capture (ha)	€ 19,734	€ 19,734
GI for education (no.)	€ 9,108	€ 0
Highways, road junction pedestrian improvements (no.)	€ 231,000	€ 0
Hard drainage, culvert works (no.)	€ 231,000	€ 0

5 KPIs

KPIs for the demonstration areas have been selected from the Eklipse Challenge Framework.

In total, 38 indicators across 10 challenges have been selected. 19 of these indicators are shared with the other two lead cities, Valladolid and Izmir. A list of the KPIs is provided in Appendix 3.

Whilst 38 indicators may appear a large number, analysis of the indicators in terms of

- What input data is needed?
- How can this data be obtained?
- How can this data be evaluated to provide information for the indicator?

Shows that input data for these indicators can be gathered from a small range data capture exercises over the three years of monitoring (first year of baseline monitoring followed by two years of post-intervention monitoring). The analysis of this data will be carried out using models and methodologies that have been used in other projects. However, we will look to enhance and develop these models as part of the Urban GreenUP programme.

Table 18: Assessment of data needed and methods of data capture

What data is needed?	air quality monitor	city/national data	project delivery records	Survey	temperature measurements at ground level	water quantity measures in sewer or tree pit systems	Grand Total
Additional green infrastructure			22	2			24
Maximum surface temperature					1		1
Measuring PM2.5 and PM10 and other air pollutants	2						2
Air temperature					2		2
Trends in emissions		2					2
Water quantity						3	3
Grand Total	**2**	**2**	**22**	**2**	**3**	**3**	**34**

Many of the analyses to provide the KPI rely on the measurement of the green infrastructure interventions. The quantity of green infrastructure drives tools such as GI Val to give data on carbon capture, energy savings in building and jobs/GVA created.

Table 19: Assessment of evaluation of indicator against data gathered

Row Labels	Additional green infrastructure	Maximum surface temperature	Measuring PM2.5 and PM10	Air temperature	Trends in emissions	Water quantity
Air quality monitor						
Comparison of before and after implementation			1			
GI Val			1			
Air quality monitor Total			**2**			
City/national data						
Comparison of before and after implementation					2	
City/national data Total					**2**	
Project delivery records						
Condatis	3					
GI Index?	1					
GI Val	6					
GIS	3					
Survey	9					
Project delivery records Total	**22**					
Survey						
GIS	2					
Survey Total	**2**					
Temperature measurements at ground level						
Star Tools		1		2		
Temperature measurements at ground level Total		**1**		**2**		
Water quantity measures in sewer or tree pit systems						
GI Val						3
Water quantity measures in sewer or tree pit systems Total						**3**
Grand Total	**24**	**1**	**2**	**2**	**2**	**3**

Further work is underway to develop the monitoring methodologies, in particular for KPIs that area shared across cities.

Having identified a suite of tools and assessment methods, we have also identified opportunities to develop these tools as exploitable products from Urban GreenUP. In particular GI Val and the GI Index can be updated to take into account new data and evidence and enable use by cities across the world.

The Liverpool partners also recognise the opportunity to learn about new tools and methodologies from other cities across the Urban GreenUP partnership and the wider Eklipse partnership.

6 Ex Ante valuation

In advance of the final list of agreed KPIs for the lead cities and the other H2020 programmes in the NBS Cluster, we have used GI Val as a means to carry out an Ex Ante assessment of the cost benefit of the Urban GreenUP investments in the three Liverpool demonstration areas.

This is based on the anticipated interventions as set out in the original programme application, with some further refinement based on the more accurate information available about where some of the interventions may be located.

6.1 Baltic Corridor

The Urban GreenUP investment in NBS for this demonstration area is €1.2m. The estimated value of this investment is;

Table 20: Baltic Corridor benefits summary

Type of Value	Amount (€m)
Gross Value Added	€0.8
Increase in property value	€7.2
Wider economic value	€3.5

The breakdown of these values is shown below.

Table 21: Benefit monetisation for Baltic Corridor (values in £)

BENEFITS	BENEFIT MONETISATION		
Benefits groups	GVA value	Land and property value	Other economic value
1 Climate Change Adaptation & Mitigation	£15,050	n.a.	£373
2 Water management & Flood Alleviation	£16,318	n.a.	n.a.
3 Place & communities	£75,274	n.a.	£426,115
4 Health & Well-being	£10	n.a.	£2,645,983
5 Land & Property Values	n.a.	£6,402,904	n.a.
6 Investment	n.a.	n.a.	n.a.
7 Labour Productivity	£199,687	n.a.	n.a.
8 Tourism	£28,672	n.a.	n.a.
9 Recreation & leisure	n.a.	n.a.	£39,712
10 Biodiversity	n.a.	n.a.	£110
11 Land management	£355,727	n.a.	n.a.
TOTAL ECONOMIC VALUE OF BENEFITS	£690,738	£6,402,904	£3,072,580
	These three figures should not be added together, as they represent different kinds of value		

The value of recreation & leisure benefits has not been included in the other economic value total because of the risk of double counting

Table 22: Benefit monetisation for Baltic Corridor (values in € at 31/5/2018 exchange rate 1.1215)

BENEFITS	**BENEFIT MONETISATION**		
Benefits groups	**GVA value**	**Land and property value**	**Other economic value**
1 Climate Change Adaptation & Mitigation	€ 16,932	n.a.	€ 419
2 Water management & Flood Alleviation	€ 18,359	n.a.	n.a.
3 Place & communities	€ 84,690	n.a.	€ 479,421
4 Health & Well-being	€ 11	n.a.	€ 2,976,995
5 Land & Property Values	n.a.	€ 7,203,907	n.a.
6 Investment	n.a.	n.a.	n.a.
7 Labour Productivity	€ 224,667	n.a.	n.a.
8 Tourism	€ 32,258	n.a.	n.a.
9 Recreation & leisure	n.a.	n.a.	€ 44,679
10 Biodiversity	n.a.	n.a.	€ 123
11 Land management	€ 400,228	n.a.	n.a.
TOTAL ECONOMIC VALUE OF BENEFITS	€ 777,149	€ 7,203,907	€ 3,501,640
	These three figures should not be added together, as they represent different kinds of value		

As is common with many green infrastructure investments, the projected increase in walking and physical exercise drives the value of wider economic benefits.

The Net Present Value of the investment is estimated to be

The quantification of benefits is shown in Table 23

Table 23: Benefit quantification for Baltic Corridor

BENEFITS Benefits groups	BENEFIT QUANTIFICATION	
1 Climate Change Adaptation & Mitigation	37,200	kWh/yr. energy saved
	6,860	$kgCO_2$/yr. not emitted
	13.6	°C in surf. temperature reduction
	0	kWh/yr. energy saved
	0	$kgCO_2$ not emitted
	48	$kgCO_2$/yr. sequestered
2 Water management & Flood Alleviation	17,500,000	L/yr. water diverted from sewers
3 Place & communities	340	more households with a view of green space
	10	new volunteers
4 Health & Well-being	0.13	lives saved per yr.
	0.00	t/yr. of carbon monoxide removed
	0.00	t/yr. of sulphur dioxide removed
	0.00	t/yr. of nitrogen dioxide removed
	0.00	t/yr. of PM10 removed

BENEFITS	BENEFIT QUANTIFICATION	
	0.00	t/yr. of ozone removed
7 Labour Productivity	Between	
	123	And
	655	work days lost avoided per yr.
8 Tourism	100	Visitor days
	0	FTE jobs
9 Recreation & leisure	1,000	Local users
10 Biodiversity	0	Ha of land w/ biodiversity value added
11 Land management	2	FTE jobs

The air quality tool in GI Val shows that the impact of the NBS at this level is difficult to quantify using the model available. The on-site monitoring may provide better data to improve the model.

The same format to show the use of GI Val for two other demonstration areas is used in the sections below.

6.2 City Centre BID

The Urban GreenUP investment in NBS for this demonstration area is €0.77m. The estimated value of this investment is:

Table 24: City Centre BID benefits summary

Type of Value	Amount (€m)
Gross Value Added	€1.6m
Increase in property value	€1.5m
Wider economic value	€25m

Table 25: City Centre BID green infrastructure valuation

Benefits groups	GVA value	Land and property value	Other economic value
1 Climate Change Adaptation & Mitigation	£321	n.a.	£22
2 Water management & Flood Alleviation	£78	n.a.	n.a.
3 Place & communities	£752,737	n.a.	£1,258,271
4 Health & Well-being	£14	n.a.	£21,331,644
5 Land & Property Values	n.a.	£1,368,303	n.a.
6 Investment	n.a.	n.a.	n.a.
7 Labour Productivity	£0	n.a.	n.a.
8 Tourism	£337,322	n.a.	n.a.
9 Recreation & leisure	n.a.	n.a.	£3,687
10 Biodiversity	n.a.	n.a.	£1
11 Land management	£355,727	n.a.	n.a.
TOTAL ECONOMIC VALUE OF BENEFITS	£1,446,198	£1,368,303	£22,589,939
	These three figures should not be added together, as they represent different kinds of value		
	The value of recreation & leisure benefits has not been included in the other economic value total because of the risk of double counting		

Table 26: City Centre BID green infrastructure valuation – (values in € at 31/5/2018 exchange rate 1.1215)

BENEFITS	BENEFIT MONETISATION		
Benefits groups	GVA value	Land and property value	Other economic value
1 Climate Change Adaptation & Mitigation	€ 361	n.a.	€ 24
2 Water management & Flood Alleviation	€ 87	n.a.	n.a.
3 Place & communities	€ 846,904	n.a.	€ 1,415,680
4 Health & Well-being	€ 15	n.a.	€ 24,000,232
5 Land & Property Values	n.a.	€ 1,539,477	n.a.
6 Investment	n.a.	n.a.	n.a.
7 Labour Productivity	€ -	n.a.	n.a.
8 Tourism	€ 379,520.98	n.a.	n.a.
9 Recreation & leisure	n.a.	n.a.	€ 4,148
10 Biodiversity	n.a.	n.a.	€ 1
11 Land management	€ 400,228	n.a.	n.a.
TOTAL ECONOMIC VALUE OF BENEFITS	€ 1,627,118	€ 1,539,477	€ 25,420,087
	These three figures should not be added together, as they represent different kinds of value		

The value of recreation & leisure benefits has not been included in the other economic value total because of

the risk of double counting

For the City Centre BID, the GVA impacts are double the investment value in NBS. Again, the health benefits drive the high value of wider economic benefits.

Table 27: City Centre BID quantification of benefits

BENEFITS			BENEFIT QUANTIFICATION
Benefits groups	**Functions**	**Tools**	
1 Climate Change Adaptation & Mitigation	Shelter from wind	1.1 Reduced building energy consumption for heating	0 kWh/yr energy saved
		1.2 Avoided carbon emissions from building energy saving for heating	0 $kgCO_2$/yr not emitted
	Reduction of urban heat island effect	1.4 Reduced peak summer surface temperatures	0.33 °C in surf. temperature reduction
	Cooling through shading and evapo-transpiration	1.5 Reduced building energy consumption for for cooling	495 kWh/yr energy saved
		1.6 Avoided carbon emissions from building energy saving for cooling	248 $kgCO_2$ not emitted
	Carbon storage and sequestration	1.7 Carbon stored and sequestered in woodland and forests	58 $kgCO_2$/yr sequestered
2 Water management & Flood Alleviation	Interception, storage and inflitration of rainwater	2.1 Energy and carbon emissions savings from reduced stormwater volume entering combined sewers	83,100 L/yr water diverted from sewers
3 Place & communities	Catalyst for community cohesion and pride	3.1 Willingness to pay for a view of urban green space	1000 more households with a view of green space
		3.2 Increase in volunteering	100 new volunteers
4 Health & Well-being	Provision of attractive opportunities for exercise	4.2 Reduced mortality from increased walking and cycling	1.06 lives saved per yr
	Air pollution removal	4.6 Avoided costs for air pollution control measures	0.00 t/yr of carbon monoxide removed 0.00 t/yr of sulfur dioxide removed 0.00 t/yr of nitrogen dioxide removed 0.00 t/yr of PM10 removed 0.00 t/yr of ozone removed
7 Labour Productivity	Attraction and retaintion of high quality staff	7.3 Savings from reduced absenteism from work	Between 0 and 0 work days lost avoided per yr
8 Tourism	Tourism attraction	8.1 Tourism expenditure	1,000 Visitor days
		8.2 Employment supported by tourism	1 FTE jobs
9 Recreation & leisure	Provision of recreation opportunities	9.1 Recreational value for use by local population	100 Local users
10 Biodiversity	Provision of recreation opportunities	10.1 Willingness to pay for protection or enhancement of biodiversity	0 Ha of land w / biodiversity value added
11 Land management	Land management	11.2 Employment supported by land management	2 FTE jobs

6.3 Jericho Lane

The Urban GreenUP investment in NBS for this demonstration area is €0.46m. The estimated value of this investment is as per the table below:

Table 28: Jericho Lane benefits summary

Type of Value	Amount (€m)
Gross Value Added	€0.6
Increase in property value	€2.5
Wider economic value	€4.9

Table 29: Jericho green infrastructure benefits valuation

BENEFITS	BENEFIT MONETISATION		
Benefits groups	GVA value	Land and property value	Other economic value
1 Climate Change Adaptation & Mitigation	£0	n.a.	£0
2 Water management & Flood Alleviation	£13,520	n.a.	n.a.
3 Place & communities	£52,692	n.a.	£277,891
4 Health & Well-being	£0	n.a.	£4,114,310
5 Land & Property Values	n.a.	£2,182,806	n.a.
6 Investment	n.a.	n.a.	n.a.
7 Labour Productivity	£113,426	n.a.	n.a.
8 Tourism	£0	n.a.	n.a.
9 Recreation & leisure	n.a.	n.a.	£18,436
10 Biodiversity	n.a.	n.a.	£33
11 Land management	£355,727	n.a.	n.a.
TOTAL ECONOMIC VALUE OF BENEFITS	£535,365	£2,182,806	£4,392,234

Table 30: green infrastructure valuation – (values in € at 31/5/2018 exchange rate 1.1215)

BENEFITS Benefits groups	BENEFIT MONETISATION GVA value	Land and property value	Other economic value
1 Climate Change Adaptation & Mitigation	€ -	n.a.	€ -
2 Water management & Flood Alleviation	€ 15,211	n.a.	n.a.
3 Place & communities	€ 59,284	n.a.	€ 312,655
4 Health & Well-being	€ -	n.a.	€ 4,629,010
5 Land & Property Values	n.a.	€ 2,455,875	n.a.
6 Investment	n.a.	n.a.	n.a.
7 Labour Productivity	€ 127,616	n.a.	n.a.
8 Tourism	€ -	n.a.	n.a.
9 Recreation & leisure	n.a.	n.a.	€ 20,742
10 Biodiversity	n.a.	n.a.	€ 37
11 Land management	€ 400,228	n.a.	n.a.
TOTAL ECONOMIC VALUE OF BENEFITS	€ 602,339	€ 2,455,875	€ 4,962,445
	These three figures should not be added together, as they represent different kinds of value		

A similar pattern to the other areas emerges for the valuation of Jericho Lane interventions. Again, the return on investment in NBS is significant. For the elements such as air quality and water management where the benefits valuation is still evolving, the monitoring of the impacts of Urban GreenUP interventions can help to improve GI Val and other tools.

Table 31: Jericho Lane benefits quantification

BENEFITS			**BENEFIT QUANTIFICATION**
Benefits groups	**Functions**	**Tools**	
1 Climate Change Adaptation & Mitigation	Shelter from wind	1.1 Reduced building energy consumption for heating	0.00 kWh/yr energy saved
		1.2 Avoided carbon emissions from building energy saving for heating	0.00 $kgCO_2$/yr not emitted
	Reduction of urban heat island effect	1.4 Reduced peak summer surface temperatures	0.06 °C in surf. temperature reduction
	Cooling through shading and evapo-transpiration	1.5 Reduced building energy consumption for for cooling	0.00 kWh/yr energy saved
		1.6 Avoided carbon emissions from building energy saving for cooling	0.00 $kgCO_2$ not emitted
	Carbon storage and sequestration	1.7 Carbon stored and sequestered in woodland and forests	0.00 $kgCO_2$/yr sequestered
2 Water management & Flood Alleviation	Interception, storage and inflitration of rainwater	2.1 Energy and carbon emissions savings from reduced stormwater volume entering combined sewers	14,500,000 L/yr water diverted from sewers
3 Place & communities	Catalyst for community cohesion and pride	3.1 Willingness to pay for a view of urban green space	222 more households with a view of green space
		3.2 Increase in volunteering	7 new volunteers
4 Health & Well-being	Provision of attractive opportunities for exercise	4.2 Reduced mortality from increased walking and cycling	0.20 lives saved per yr
	Air pollution removal	4.6 Avoided costs for air pollution control measures	0.00 t/yr of carbon monoxide removed 0.00 t/yr of sulfur dioxide removed 0.00 t/yr of nitrogen dioxide removed 0.00 t/yr of PM10 removed 0.00 t/yr of ozone removed
7 Labour Productivity	Attraction and retaintion of high quality staff	7.3 Savings from reduced absenteism from work	Between 35 and 186 work days lost avoided per yr
8 Tourism	Tourism attraction	8.1 Tourism expenditure	500 Visitor days
		8.2 Employment supported by tourism	0 FTE jobs
9 Recreation & leisure	Provision of recreation opportunities	9.1 Recreational value for use by local population	500 Local users
10 Biodiversity	Provision of recreation opportunities	10.1 Willingness to pay for protection or enhancement of biodiversity	0 Ha of land w/ biodiversity value added
11 Land management	Land management	11.2 Employment supported by land management	2 FTE jobs

6.4 Work with schools in the vicinity of the intervention areas.

As described above, our diagnosis and demonstration area assessment has led us to include schools close to the demonstration areas in our plans.

Engaging schools can not only assist in supporting greater levels of physical activity but can also assist in the implementation of wider Urban Catchment Forestry work and help to improve city air quality as well as lock up carbon from trees and woodland planted on these school sites. Engagement of children can also help to increase awareness of nature based solutions and improve connectedness to nature, essential is NBS are to be seen in the future as a key component of living and working in cities and urban areas.

As part of the Trees for Learning programme, a Social Return on Investment (SROI) for work to create new woodlands and increase children's connectedness to nature has been developed. This provides an additional tool to help identify the benefits of Urban GreenUP interventions.

Table 32 provides an overview of the model. Using estimated data for Urban GreenUP interventions, a total SROI of €1.4m is attained based on this model.

Table 32: Extract from SROI for work with schools delivering NBS

Stakeholders	Total population	Inputs	Outputs	Outcome	Indicator description	Source	Indicator result: Units	Outcome incidence	Financial proxy description	Proxy	Source
Children	1000	Time	2893 Children involved in tree planting programme	Improved mental wellbeing due to increased happiness, connection with nature	No. of children participating in programme	Community Forest data	No. of children	1000	Value of being relieved from depression or anxiety (under 25s)	£11,819	HACT Social Value Calculator
				Improved physical health due to increased activity	No. of children participating in programme	Community Forest data	No. of children	1000	Value of frequent moderate exercise (under 25s)	£3,848	HACT Social Value Calculator
				Improved confidence due to exploring more places, learning new skills	No. of children participating in programme	Community Forest data	No. of children	1000	Value of improvement in confidence (under 25s)	£9,283	HACT Social Value Calculator
				Improved learning due to improved attention span, restorative effect of nature	No. of children participating in programme	Community Forest data	No. of children	1000	Value of regular volunteering (under 25s)	£2,895	HACT Social Value Calculator
Parents / carers (assumption that 0.8 parent : 1 child)	200	Time	2314 Parents involved in tree planting programme	Decreased stress as improved behaviour of child, also spending time in nature	No. of children participating in programme (assumed 1:1 ratio of children to parent/carer at home)	Community Forest data	No. of children	1000	Value of being relieved from depression or anxiety (adult)	£36,766	HACT 2014: Measuring the Social Impact of Community Investment: A Guide to Using the Wellbeing Valuation Approach
				Improved physical health due to increased activity (children as agents of change in family)	No. of parents participating in programme	Community Forest data	No. of parents	200	Value of frequent moderate exercise (adult)	£2,880	HACT Social Value Calculator
				Less money spent in local economy as more time spent outdoors as a family (children as agents of change in family)	No. of parents participating in programme	Community Forest data	No. of parents	200	Average weekly recreation spend per family in UK (as a loss)	£68	ONS Family Spending Report 2016
Teachers (involved in programme)	12	Time	X Teachers involved in tree planting programme	Reduced teacher stress due to improved student behaviour, and restorative effect of spending time in nature themselves	No. of teachers participating in programme	Community Forest data	No. of teachers	12	Value to an individual of being relieved from depression or anxiety p.a.	£36,766	HACT 2014: Measuring the Social Impact of Community Investment: A Guide to Using the Wellbeing Valuation Approach
Teachers (total staff at participating schools)	600	N/A	X Teaching staff at participating schools	Improved teacher recruitment due to better school environment/ image	No. of teaching staff	School data	No. of teaching staff	600	Average teacher recruitment cost in the UK	£3,000	NAHT recruitment survey 2015
				Improved teacher retention due to better school environment/ image	No. of teaching staff	School data	No. of teaching staff	600	Average teacher recruitment cost in the UK	£3,000	NAHT recruitment survey 2015
NHS	1	N/A		Cost savings as fewer GP visits due to improved physical and mental health of participants	No. of participants	Community Forest data	No. of participants (children+parents+teachers)	1212	Cost of a GP visit	£39	Land Trust 2015: Perceptions Survey and and Social Value Study

Annex A1. Related documents

Document	Link
Baltic Triangle Regeneration Framework	http://regeneratingliverpool.com/project/baltic-triangle/ (also included in Urban GreenUP project folder)
City Centre Mayoral Development Zone	http://regeneratingliverpool.com/zone/liverpool-city-enterprise-zone/
City BID	https://www.liverpoolbidcompany.com/resources/
Liverpool Green and Open Spaces Review	http://liverpool.gov.uk/mayor/mayoral-commissions/strategic-green-and-open-spaces-review-board/
Liverpool Green Infrastructure Strategy	http://www.greeninfrastructurenw.co.uk/liverpool/
Liverpool BID GI Opportunities	Attached (included in Urban GreenUP project folder)

Annex A2. Mapping methods

Adult obesity

Prevalence of obesity in adults 2003-5 at Middle Layer Super Output Area level (The NHS Information Centre)

Childhood obesity

Prevalence of obesity in children at Reception and Year 6, 2012/13 to 2014/15, at Middle Layer Super Output Area level (Public Health England)

(Note that some values are missing for confidentiality reasons)

Coronary Heart Disease

Hospital admissions for Coronary Heart Disease per unit population 2007-8 at Middle Layer Super Output Area level (Office for National Statistics)

Index of risk of poor mental health

As suggested by Moscone et al (2006)[54], the following regressors were used to calculate the index. All are taken from Census 2011 statistics except for the last, which are Office for National Statistics model-based estimates for 2007-8. The index is simply the sum of the percentages at Lower Layer Super Output Area level.

- Percentage of population aged 0-15
- Percentage of population aged 65+
- Percentage of females in the population
- Percentage of population living alone
- Percentage of population with no qualifications
- Percentage of population with a long-term health problem or disability
- Percentage of households in poverty (below 60% of median income

Green infrastructure typology

1. The latest version of Ordnance Survey's MasterMap Topography Layer was downloaded

[54] Moscone, F, Knapp, M and Tosetti, E, Mental Health Expenditure in England: A Spatial Panel Approach (2006). Available at SSRN: https://ssrn.com/abstract=898474 or http://dx.doi.org/10.2139/ssrn.898474

2. Polygon features intersecting a 1km buffer of the Liverpool City Council boundary were extracted
3. Features where DescGroup like 'Landform%' were deleted, as these overlap other features
4. The result was unioned with Ordnance Survey's MasterMap Greenspace Layer
5. Features were classified according to MasterMap Greenspace attributes as follows (in the order given, only classifying at each step features not previously classified)

Attribute	**Value**	**Type**
priForm	Beach Or Foreshore	Coastal habitat
priForm	Manmade Surface	Not GI
priForm	Woodland	Woodland
priFunc	Allotments Or Community Growing Spaces	Allotment, community garden or urban farm
priFunc	Amenity - Transport	General amenity space
priFunc	Bowling Green	Outdoor sports facility
priFunc	Cemetery	Cemetery, churchyard or burial ground
priFunc	Golf Course	Outdoor sports facility
priFunc	Institutional Grounds	Institutional grounds
priFunc	Other Sports Facility	Outdoor sports facility
priFunc	Play Space	Park or public garden
priFunc	Playing Field	General amenity space
priFunc	Private Garden	Private domestic garden
priFunc	Public Park Or Garden	Park or public garden
priFunc	Religious Grounds	Institutional grounds
priFunc	School Grounds	Institutional grounds
priFunc	Tennis Court	Outdoor sports facility

6. Features were classified according to MasterMap Topography attributes as follows (overwriting previous classifications)

Attribute	**Value**	**Type**
Make	Manmade	Not GI
DescTerm	Orchard	Orchard
DescTerm	Marsh%	Wetland

7. Features were classified as per matching features in the previous green infrastructure mapping (only classifying features not previously classified)
8. Features were classified according to MasterMap Greenspace attributes as follows (in the order given, only classifying at each step features not previously classified)

Attribute	**Value**	**Type**
priForm	Inland Water	Water body
priForm	Open Semi-Natural	Grassland, heathland, moorland or scrubland
priFunc	Camping Or Caravan Park	Institutional grounds
priFunc	Land Use Changing	Institutional grounds
priFunc	Amenity – Residential Or Business	Institutional grounds

9. Features were classified according to MasterMap Topography attributes as follows (in the order given, only classifying at each step features not previously classified)

Attribute	**Value**	**Type**
DescTerm	%Trees% and not %Scattered%	Woodland
DescTerm	Foreshore	Coastal habitat
DescTerm	Scrub	Grassland, heathland, moorland or scrubland

DescTerm	Multi Surface	Private domestic garden
DescGroup	Inland Water%	Water body
DescGroup	Rail%	Grassland, heathland, moorland or scrubland
DescGroup	Roadside%	General amenity space
DescGroup	Tidal Water	Water course
DescGroup	Unclassified	Not GI
DescGroup	Road Or Track%	Not GI
DescGroup	Natural Environment	Grassland, heathland, moorland or scrubland

10. Remaining features larger than 1,000m^2 were classified by visual comparison with aerial photography
11. Remaining feature were classified as institutional grounds
12. Features with more than 50% tree canopy cover (according to Bluesky's National Tree Map) were classified as woodland where they met the following conditions (overwriting previous classifications)
    - Area > 1,000m^2
    - DescGroup not like Road Or Track%
    - DescGroup not like Building%
    - DescGroup not Inland Water
    - DescGroup not like Roadside%
    - Type not Private domestic garden
13. Features classified as street trees were reclassified as general amenity space
14. The result was updated with tree crowns (from Bluesky's National Tree Map) with their centroids within a metre of roads and roadside – these were classified as street trees
15. Some incorrectly classified features were fixed by visual comparison with aerial photography and Ordnance Survey background mapping

Importance of existing habitat for northwards species movement

Condatis flow maps using the following parameters:

Habitat: 200m rasters of:

- Tree canopy cover
- Inland water
- Wetland
- Coastal habitat
- Intensively-managed grassland
- Less intensively-managed grassland

These were based upon the green infrastructure typology mapping, with the exception of tree canopy cover, which was based upon Bluesky's National Tree Map

General amenity space, green roof, institutional grounds, outdoor sports facility, park or public garden and private domestic garden were counted as intensively-managed grassland

Grassland, heathland, moorland or scrubland, cemetery, churchyard or burial ground and derelict land were counted as less intensively-managed grassland

Source/target: assigned to simulate south-north movement through Liverpool, taking into account the extent of the input data

Dispersal distances: 1km and 2km

Bottlenecks in northward movement of species

Condatis bottlenecks maps using the same parameters as above

Temperature (baseline), Temperature (2050s), Runoff (baseline), Runoff (2050s)

Results from the STAR tools for 2011 Lower Layer Super Output Areas near the sub-demo areas, using current land cover

Water quality

Environment Agency pollution incidents (2001-15) that had an impact on water quality

Environment Agency historic landfill sites

Active travel

Ordnance Survey MasterMap Integrated Transport Network Urban Paths

Liverpool City Council Public Rights of Way

Sustrans National Cycle Network

Surface water flooding

Environment Agency Updated Flood Map for Surface Water

Liverpool City Council/United Utilities ranked hotspots

Runoff lines generated from the Environment Agency's 1m-resolution digital surface model using Global Mapper's Generate Watershed command (to illustrate what might happen if the drainage system was overwhelmed)

Climate resilience

Mapping from the report 'Green infrastructure: how and where can it help the Northwest mitigate and adapt to climate change?' which was written by Community Forests North West for the North West Development Agency in 2010, showing the number of climate change services delivered by green infrastructure that it was considered important to safeguard or enhance in each location

Green space

Liverpool City Council Open Space Survey 2015

Older people

Department for Communities and Local Government Indices of Deprivation 2015: supplementary index: income deprivation affecting older people

Urban regeneration

Regeneration schemes listed at http://liverpool.gov.uk/business/regenerating-liverpool/

Number of issues

For each issue, locations were identified where the issue is most severe, using the following criteria. These are mostly based upon the individual issue maps. The sum of these binary layers was calculated to give the number of issues in each location.

Issue	Criteria
Urban heat island	2050s temperature > 32°
Flooding	2050s runoff > 90%, 100-year flood outline, or ranked hotspot
Species movement	Bottlenecks 100m buffer: trees power > 0.00002, intensive grassland power > 0.00003, less intensive grassland power >

	0.00001
Active travel	Density of active travel routes less than 1km per sq. km
Water quality	50m buffer of A roads and dual carriageways
Perception of greenspace	Density of publicly accessible greenspace less than 0.1
Older people	IMD income deprivation affecting older people rank < 1000
Regeneration	Regeneration areas
Physical activity	Prevalence of adult obesity > 25%, prevalence of Reception obesity > 15%, prevalence of Year 6 obesity > 25%, or hospital admissions for CHD per unit population > 0.03
Mental health and well-being	Index of risk of poor mental health > 0.25

Annex A3. KPIs

See attached Spreadsheet