Liverpool City Region and Warrington

Green Infrastructure Framework

Technical Document

Version 1.2

September 2013

Contents

1. References

All references in this document were checked as being correct citations on 27th November 2012. All websites referenced to as sources of data or other information were also checked on 27th November 2012.

2. Glossary

Table 1 Glossary of terms used in this framework

Term	
Asset	Green infrastructure that is delivering a function or functions in an area of identified need. For example, woodland that is intercepting and storing water in an area of flood risk is a water management asset; it is providing functions that help to reduce the risk of flooding.
Benefits	Green infrastructure planning is set firmly in the context of public benefit. There are many ways of identifying and categorising benefits. The Natural Economy Northwest project developed a model of eleven benefits that has now been taken up by a range of organisations in the region and across the country. This is used in this strategy.
Ecosystem Services approach	An ecosystems approach provides a framework for looking at whole ecosystems in decision making, and for valuing the ecosystem services they provide, to ensure that society can maintain a healthy and resilient natural environment now and for future generations.
Functions	Describes what the green infrastructure type does; it could range from intercepting water to reducing noise. In this framework we look at 28 functions.
Green Infrastructure	Our life support system – the network of natural environmental components and green and blue spaces that lies within and our towns and city and provides multiple social, economic and environmental benefits.
Green Infrastructure Planning	Assessment and geographical expression of issues related to Green infrastructure and in particular identifying interdisciplinary and comprehensive approaches directed towards sustainable development. These will include land use management and land use planning.
Multi-functionality	One of the strengths of a green infrastructure approach is that it can be used to deliver several functions from a single intervention. For example, the opportunity to expand a key habitat may also provide an opportunity to improve water management, improve image and capture air borne pollution. Often, because the wider functions are not considered, the opportunities to get more value from an intervention are not taken.
Pinch Point	Area where a need has been identified and where green infrastructure could provide part of the solution to address the need but at present is not.
Type Value	A description of the elements that make up our green infrastructure. In developing a typology the Planning Policy Guidance 17[1] (PPG17) has been used as a starting point, with the addition of a range of different types so that all land cover is included. PPG 17 is still being used by Local Authorities as a reference for land typologies and it made sense to add to this rather than attempt to develop a new list. Where possible we should attempt to put an economic value of green infrastructure investments, recognising that the natural environment has intrinsic value, but mindful that political and investment decisions often also are informed by economic assessment.

[1] http://www.planningportal.gov.uk/planning/planningpolicyandlegislation/previousenglishpolicy/ppgpps/ppg17

3. Background

Green Infrastructure (GI) planning highlights the role of the natural environment in enabling our economy and society to function.

GI is therefore a critical infrastructure. It needs to be considered and planned for in the same way as water, waste, transport and energy infrastructure for a successful and resilient Liverpool City Region and Warrington.

In simple terms green infrastructure is the vegetation and all of the open water found in our area.

Liverpool City Region Green Infrastructure Framework has been prepared at a time of great change. It was originally mandated by the Environment and Waste Board, a sub group of the Liverpool City Region Board, which considered issues requiring coordinated activity across administrative boundaries with implications for the economic success, quality of life and sustainable development of the City Region.

With the publication of the National Planning Policy Framework[2] and the Natural Environment White Paper[3] the GI Framework is now of particular relevance to the City Region Planning Board, Local Economic Partnership and the Local Nature Partnership.

The delivery of the activities and actions set out in this framework have been approved by the Local Nature Partnership and now form an important strand of its delivery plan.

Natural England and the Mersey Forest Partnership have provided the funding to undertake the work, and a wide range of partners have invested time and effort into helping to shape the development of the framework.

The Mersey Forest Team has co-ordinated the work and partner input, carried out the mapping, analysis, prepared the documents and undertook consultation with stakeholders.

The Framework provides new information and perspectives on green infrastructure across seven local authorities.

Green infrastructure planning at this spatial scale is also supported by the Local Enterprise Partnership (LEP) through the original LEP application, the Atlantic Gateway Programme through 'Adapting the Landscape'[4], and also in the City Region work by Lord Heseltine and Sir Terry Leahy[5].

In their report, Leahy and Heseltine describe the need to rebalance the economy to increase manufacturing capability and move more activity from the south of England to the northwest. It also describes the role that high quality green infrastructure can play in helping to achieve this change.

"..and to create a green infrastructure that will propel Liverpool (City Region) into the global premier league of green, attractive cities to invest and live in."

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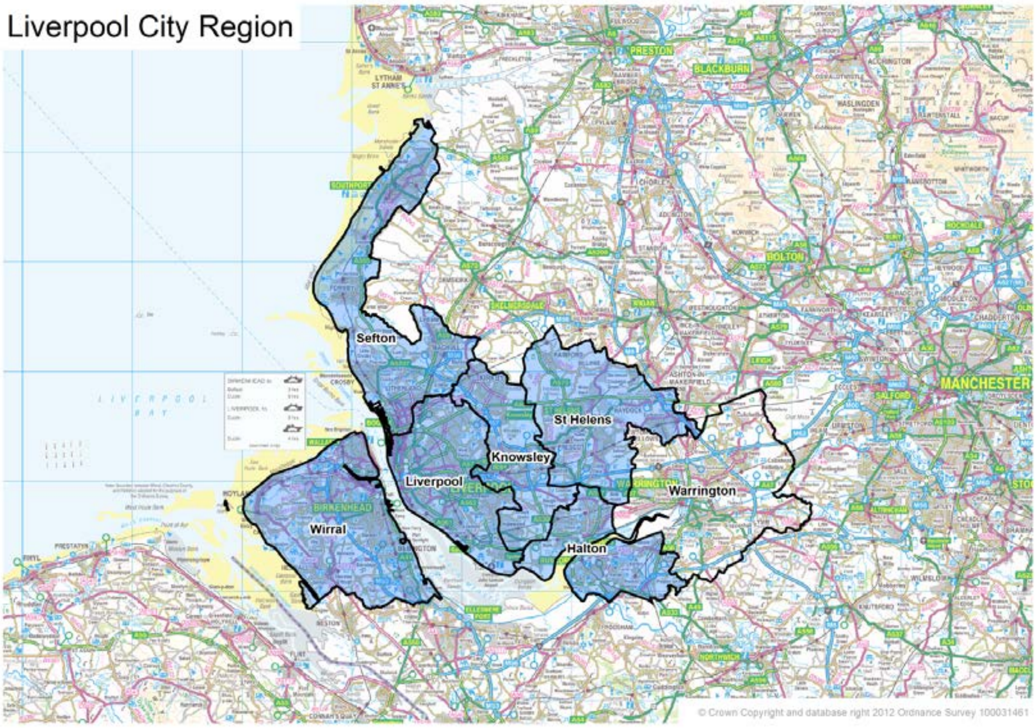
[2] www.communities.gov.uk/planningandbuilding/planningsystem/planningpolicy/planningpolicyframework/ Department for Communities and Local Government (2012) National Planning Policy Framework. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf

[3] www.defra.gov.uk/environment/natural/whitepaper/ DEFRA (2011) The natural choice: securing the value of nature. DEFRA, London. Available at: http://www.official-documents.gov.uk/document/cm80/8082/8082.pdf

[4] http://atlanticgateway.co.uk/ http://atlanticgateway.co.uk/

[5] www.bis.gov.uk/assets/biscore/economic-development/docs/r/11-1338-rebalancing-britain-liverpool-city-region Heseltine, C.H. and Leahy, T. (2011) Rebalancing Britain: policy or slogan? Liverpool City Region – Building on its Strengths: An independent report. Available at: www.bis.gov.uk/assets/biscore/economic-development/docs/r/11-1338-rebalancing-britain-liverpool-city-region

Map 1 Liverpool City Region and Warrington



Warrington, whilst not in the Liverpool City Region, is also included in this Framework. The rationale for this is that there is a great deal of joint work on green infrastructure, housing, transport and economic development across the Warrington, St.Helens and Halton area and it makes planning sense for Warrington to be involved in this framework.

Liverpool City Region Green Infrastructure Framework should not be viewed in isolation. It builds on a great deal of work that has been undertaken in the northwest of England over the last seven years and complements the work that has been undertaken by neighbouring areas:

- Manchester Green Infrastructure Framework[6]
- Lancashire Green Infrastructure Strategy [7]
- Cheshire West and Chester Green Infrastructure Framework[8]

[6] www.agma.gov.uk/cms_media/files/summary_report11.pdf
AGMA, Natural England and TEP (2008) Towards a Green Infrastructure Framework for Greater Manchester. Available at: www.agma.gov.uk/cms_media/files/summary_report11.pdf

[7] Lancashire Economic Partnership (2009) Lancashire Green Infrastructure Strategy. Available at: http://www.blackpool.gov.uk/NR/rdonlyres/C4496366-CEEA-4E48-8176-36789E30764A/0/LancsGreenInfrastructure2009.pdf

[8] Mersey Dee Alliance (2011) Green Infrastructure Framework for North East Wales, Cheshire and Wirral. Available at: www.merseydeealliance.org.uk/projects/green_infrastructure.aspx

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Warrington sits in the middle of these green infrastructure frameworks listed above and it is important that in this framework the actions for Warrington in particular link well with these neighbouring green infrastructure frameworks or strategies.

Building on Green Infrastructure Planning in the North West of England

Green infrastructure planning has developed significantly in northwest England over the last few years.[9] From the first landscape scale green infrastructure framework produced for The Mersey Belt through to The Natural Economy North West Programme[10]. NENW in particular made significant progress in developing the economic case for green infrastructure planning and implementation, producing leading edge studies and information that have been used as the basis for this framework.

There has also been a significant amount of work across the North West looking at the climate change adaptation and mitigation benefits of green infrastructure[11]. This has produced a range of resources, including a guidance document to aid policy development and delivery entitled 'Green Infrastructure to Combat Climate Change: A Framework for Action in Cheshire, Cumbria, Greater Manchester, Lancashire, and Merseyside'.

This framework also builds on the methodology and ideas that were developed in order to prepare the Liverpool Green Infrastructure Strategy[12]. The mapping methodology for this framework has been supported by Ordnance Survey and the Royal Institute of Chartered Surveyors and published as a reference for green infrastructure mapping[13].

[9] http://www.greeninfrastructurenw.co.uk/resources/GI_for_the_Liverpool_&_Manchester_city-regions.pdf TEP (2005) Green Infrastructure for the Liverpool and Manchester City-regions. Available at: www.greeninfrastructurenw.co.uk/resources/GI_for_the_Liverpool_&_Manchester_city-regions.pdf

[10] www.naturaleconomynorthwest.co.uk/

[11] www.ginw.co.uk/climatechange www.ginw.co.uk/climatechange; This was undertaken under the auspices of the Northwest Climate Change Action Plan, with Community Forests Northwest commissioned by the Northwest Regional Development Agency on behalf of the Northwest Climate Change Partnership. The work was supported through the EU Interreg IVC GRaBS (Green and Blue Space Adaptation for Urban Areas and Eco-Towns) project.

[11] www.ginw.co.uk/liverpool

[12] see 11

[13] 10179 The Mersey Forest and Ordnance Survey (2011) The Value of Mapping Green Infrastructure, Royal Institute for Chartered Surveyors, Coventry. Available at: http://www.merseyforest.org.uk/files/The_Value_of_Mapping_Green_Infrastructure_pdf.pdf

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Why develop a Green Infrastructure Framework?

Planned, implemented and managed appropriately, our natural environment can provide a range of benefits to support our economy and improve quality of place and life.

Green infrastructure identifies the functionality and benefits we derive from the natural environment and in particular how it helps to achieve the long term strategic ambitions for sustainable growth.

The Liverpool City Region and Warrington Green Infrastructure Framework sets out to answer a number of key questions about the role of the natural environment in helping to address important issues. For example

- *“What and where are the "pinch points" constraining economic investment in the sub region and Warrington and what are the potential green infrastructure solutions?”*

- *“How can green infrastructure play a role in supporting the 5 Ways to Health and Wellbeing across the city region?”*

- *“How can GI planning and delivery assist in improving the water quality of the River Mersey and its tributaries?”*

At a city region level we can use green infrastructure mapping in conjunction with a wide range of other datasets to help answer these and other important questions.

We can also identify, spatially, the City Region Green Infrastructure Framework as an evidence base for planning.

This information can be used to help demonstrate key links to other investment plans, such as those for the new EU Structural and Rural Development funds, Atlantic Gateway, the health sector or other environmental stewardship programmes.

In addition the framework aims to provide an opportunity for individuals, groups and organisations to focus on key, shared priorities for the city region. It also can identify and target resources at areas of greatest need across the city region and Warrington.

In a time of financial restraint, it is essential that Liverpool City Region use all available assets to try to achieve the aspirations for the economy, improved health, creating high quality places to live within a rich and biodiverse natural environment. This framework identifies how green infrastructure planning and delivery can help to achieve these aspirations.

The Government's emerging planning policies and focus on localism can be supported through this Framework as it provides data, evidence and actions that can be looked at locally, at local authority or neighbourhood level to help to inform decision making and support sustainable development - still a key part of the government agenda.

4. Purpose

The Liverpool City Region Green Infrastructure Framework has been developed in order to;

- For the first time produce an **evidence base** of the city region's green infrastructure to help inform decisions about land use planning and management.

- **Advocat**e for green infrastructure to be planned and managed as a critical infrastructure that can and should be used to help tackle priority issues for the city region.

- **Identify actions** at a city region level that meet key priorities.

- Form the basis for a **programme of investment** at a city region level that can bring together organisations from a range of sectors to cooperate, increase their impact, and focus on critical issues which provide mutual benefits.

These will:

- Ensure good use of resources at the city region level
- Bring a wide range of professions and organisations together
- Provide a framework for the sustainable land management of the study area
- Provide a tool for predicting the implications of change on the natural environment
- Present an accurate picture of the green infrastructure of the study area – essential in making planning decisions and informing developments and strategies
- Provide a tool for delivering the natural environmental contribution to identified priorities in the fields of health, economy, quality of life and so on
- Provide a structured plan for delivering environmental change.
- Attract funding by demonstrating researched needs and outcomes
- Attract inward investment

5. Format

Liverpool City Region Green Infrastructure Framework has four components:

- Green Infrastructure Database - Held by Mersey Forest Team and made available to partners for use for local planning and strategy development. This contains all of the data sets produced as part of this Framework and a data "information tool" to enable information to be provided for specific sites or areas.

- Technical Document - Detailed background information, methodologies, evidence and analysis leading to the action plan.

- Action Plan - Providing an overview of the key actions and the opportunities that exist to deliver them.

- Prospectus – An executive summary focussed on the key issues and actions.

6. Relationship to Local Planning

Across the city region, local authorities are at different stages in the development of their Local Plans. Each has included or intends to include polices on green infrastructure in line with the draft National Planning Policy Framework (see section on Context for the Green Infrastructure Framework).

Table 2 Local Authority LDF Progress and Green Infrastructure Policy

Local Authority	Stage of LDF	GI Policy (comments or links)
Halton	Adopted	Policy CS21
Knowsley	Submission draft Nov 2012	
Liverpool	Submission draft	Proposed Policy approach 23
Sefton	Options	
St.Helens	Adopted	Policy CQL 1
Wirral	Preferred Options	Preferred Option 18
Warrington	Submission draft/examination	

The Liverpool City Region and Warrington GI Framework provides detailed information on agreed priorities that can be used to support local plans and policies, particularly around issues that cross administrative boundaries and where there may cumulative effects of development for neighbouring areas that impact on green infrastructure.

This information can then be used to support strategic city region joint working. It can also assist the development and/or implementation of local authority green infrastructure planning at all spatial scales including neighbourhood plans[14].

The Liverpool City Region - Spatial Priorities Framework 2012 to 2020 document aims to reflect the initiatives and developments, including green infrastructure that have been collectively agreed with the clear priority being that of urban regeneration and sustainable growth, particularly economic growth.

[14] Kambites, C. and Owen, S. (2006,) Renewed Prospects for Green Infrastructure Planning in the UK. Planning, Practice and Research 21(4): 483-496.

Green Infrastructure in the Liverpool City Region and Warrington Economy

Because green infrastructure is a relatively new concept there has been little work to date to assess it as a sector of the economy in the same way as may be carried out for the energy or water sector.

To start to gain information on the role that the sector plays in the economy an independent assessment of Standard Industry Codes (SIC)[15] for green infrastructure was carried out. This assessment used data from the NOMIS[16] website which provide the official labour market statistics.

Employment

Using data from NOMIS around 16000 jobs related to green infrastructure can be identified. The jobs cover a broad spectrum from tree surgery to real estate trading, landscape services to food manufacture (making an allowance for non-local produce).

A separate piece of work was carried out by Rural Innovations for The Mersey Forest Team to assess GVA of businesses involved in the green infrastructure sector.

Wages and GVA

Table 3 shows how the wages and GVA data can be split into two strands. A primary level of business that works directly on green infrastructure and a secondary level which makes use of the green infrastructure function or benefits (including products). The datasets provided by NOMIS are limited for distribution or publishing. This data is useful in identifying the scale of the sector.

Table 3 Green Infrastructure GVA

Level	Description	Examples	Wages (£000)	GVA (£000)
Primary	Work directly with green infrastructure	Grounds maintenance, tree surgeon	2,684	8,369
Secondary	Business that makes use of products from green infrastructure or uses GI to provide services	Supervisory and management of assets and workforce, food and fibre processing	426,080	701,314
Total			**428,764**	**709,683**

By far the greatest economic value comes from the value added businesses that make use of green infrastructure resources. This is similar to other sectors where relatively low values of primary input enable secondary use and a wide range of business differentiation and development. The total GVA is around **3.0%** of the City Region and Warrington total.

[15] SIC - Standard Industry Codes - used in the UK by the Office of National Statistics and elsewhere as a way to categorise all businesses and then collate and report information on business performance over time. See NOMIS database - http://www.nomisweb.co.uk/

[16] https://www.nomisweb.co.uk/default.asp

7. What is Green Infrastructure?

Definition

Green Infrastructure can be defined as:

"Our life support system – the network of natural environmental components and green and blue spaces that lies within and around our towns and city, providing multiple social, economic and environmental benefits."

The definition identifies green infrastructure as:

- A system, the parts are interrelated and need to be planned and managed at appropriate scale and together.
- Including both the vegetation and water elements of the natural environment.
- Both urban and rural
- Providing multiple benefits - one intervention, if well planned, can provide many benefits -This is one of the key advantages of taking a green infrastructure planning approach.

It is perhaps obvious, but important to highlight the difference between the resource (GI) and its planning (GI Planning). GI Planning provides an assessment and geographical expression of issues related to Green infrastructure it should link with other aspects of land use management and land use planning. Sometimes "GI" has been used to interchangeably to describe both the resource and its planning.

Development of Green Infrastructure Planning

Green infrastructure planning in the UK builds on the legacy of ideas and initiatives going back over 150 years (City Parks, Garden Cities, Green Belt, Community Forests)[17], but it differs from many conventional land conservation and natural resource protection approaches by bringing land development, man-made infrastructure planning and the natural environment together[18]. Green infrastructure planning seeks to optimise land use to meets the needs of people and nature – it is a mechanism for delivering sustainable development.

"Green Infrastructure differs from conventional approaches to open space as it looks at conservation values and action in concert with land development, growth management and built infrastructure planning, whilst other conservation approaches are typically undertaken in isolation from – or even in opposition to – development."[19]

The green infrastructure planning complements other approaches that are taken to planning and managing the natural environment. It is an ecosystems based approach that is guided by landscape considerations and when implemented effectively lead to biodiversity and ecological framework improvements.

In particular, the approach can help deliver the type of activity that is described in the "Nature at Work" scenario of the National Ecosystems Assessment published in 2011 (See

[17] Presentation by Ian Wray, Head of Planning NWDA, 4th December 2008, www.greeninfrastructurenw.org.uk Available at: http://www.greeninfrastructurenw.co.uk/resources/Merseyside_GI_lores.pdf

[18] Benedict, M.A. and McMahon, E.T. (2006) Green Infrastructure. Linking Landscapes and Communities. Island Press, Washington.

[19] Benedict, M.A. and McMahon, E.T. (2000) Green Infrastructure: Smart conservation for the 21st Century, The Conservation Fund. Available at: http://www.sactree.org/assets/files/greenprint/toolkit/b/greenInfrastructure.pdf

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Figure 23 Taken from UK National Ecosystems Assessment Synthesis Report).

The economic assessment of this particular scenario identified it as being the most beneficial scenario for towns and cities and therefore particularly important for areas such as the Liverpool City Region and Warrington.

Green Infrastructure Challenges

Green infrastructure planning is not business as usual for the environment sector. It challenges the sector to provide a robust and coherent plan, link effectively to wider key strategic priorities, engage effectively with other sectors over an extended period of time and work with a wide range of organisations involved in land use planning, management and development.

Green infrastructure Principles

Eight principles of green infrastructure planning, design and implementation have been proposed[20] to support this framework:

- Identify and protect green infrastructure assets
- Engage diverse people and organisations from a range of sectors
- Linkage is key, connecting green infrastructure components with each other and with people
- Design green infrastructure systems that function at different scales and across boundaries
- Green Infrastructure activity must be grounded in good science and planning practice
- Fund green infrastructure up-front as a primary public investment
- Emphasise green infrastructure benefits are afforded to all; to nature and people
- Green infrastructure should be the framework for natural environment projects and programmes.

[20] Benedict, M.A. and McMahon, E.T. (2000) Green Infrastructure. Linking Landscapes and Communities. Island Press, Washington.

8. Describing Green Infrastructure

A standard approach to describing green infrastructure has developed in Northwest England. It is based on a model that describes green infrastructure in terms of:

Types – A description of the elements that make up the City Region's green infrastructure. In developing a typology, PPG17[21] has been used as a starting point, with the addition of a number of additional types so that all land cover is included. For each green infrastructure type a range of functions can be identified.

Functions - Green infrastructure functions describe what the green infrastructure type does; it could range from intercepting water to reducing noise. In all, 28 functions have been identified (see Appendix 1). A particular green infrastructure type may have several functions depending on a range of factors. One of the aims of green infrastructure planning is to achieve high levels of multi-functionality where possible. More limited or single functionality is considered appropriate only where there is an overriding function that must be safeguarded due to legislation or strategic significance.

Benefits - Green infrastructure planning is set firmly in a context of public benefit. There are many ways of identifying and categorising benefits. Work by Natural Economy Northwest[22] developed a model of eleven benefits that is now widely used by a range of organisations (see Figure 1 Green infrastructure benefits) and which has also been used in this Framework. Each of the benefits consists of a mix of GI functions. For example, the flood alleviation and water management benefit is provided by four functions – water conveyance, water storage, water interception and evapotranspiration. It is also the case that each of these functions may contribute to several other benefits.

Figure 1 Green infrastructure benefits

[21] Recognising that PPG 17 has been superceded by the National Planning Policy Framework, it still provides a useful starting point for developing the green infrastructure typology and has the advantage of having been used to develop current policies and strategies.

[22] Ecotec and NENW (2008) The economic benefits of Green Infrastructure: The public and business case for investing in Green Infrastructure and a review of the underpinning evidence. Available at: http://www.naturaleconomynorthwest.co.uk/resources+reports.php

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Values – It is sometimes considered important to be able to attempt to show the value of green infrastructure in the same monetary terms so that it can be compared to other potential investments.

At present this involves identifying the economic value of a project or intervention in order to be able to compare investments and their likely return. This "market mimicking" approach to the natural environment can be controversial, but it does enable a debate about the value that may be delivered through green infrastructure investments and for comparison with other values.

The UK Treasury Green Book[23] recognises that not all environmental benefits can be monetised. Techniques have been developed and are developing to enable economic value to be ascribed to GI[24]. For example the Regeneris study of The Mersey Forest Objective 1 programme showed that for each £1 invested £2.60 of direct economic benefit was achieved and when other economic values were included the total was £10.20[25].

[23] HM Treasury (2010) The Green Book, Appraisal and Evaluation in Central Government TSO, London. Available at: http://www.hm-treasury.gov.uk/d/green_book_complete.pdf

24 Genecon (2010) Green Infrastructure Valuation toolbox. Available at: http://www.genecon.co.uk/projects/green-infrastructure-valuation-toolbox.aspx

[25] Regeneris Consulting (2009) The Economic Contribution of The Mersy Forest's Objective One-Funded Investments. Available at: http://www.merseyforest.org.uk/files/Economic%20Contribution%20report%20and%20appendices.pdf

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Recent work by Natural England has provided guidance on the quality of the evidence used to support this type of economic analysis of green infrastructure[26]. The author of the report commented,

"We believe the evidence is increasingly clear that providing good quality green space in our towns and cities can have significant economic benefits. It can promote investment, improve people's health and protect our urban communities from the worst effects of climate change – all of which translate into millions of pounds of savings for the public purse."

A Prototype Green Infrastructure Valuation Toolkit developed by a range of partners across England has also been used for several projects in the Liverpool City Region.

At Wirral Waters, green infrastructure interventions costing around £2m were shown using the Toolkit to potentially deliver £29m of NPV. Figure 2 shows the relative size of the NPV achieved across the different benefit types, with health and wellbeing benefits being the most significant.

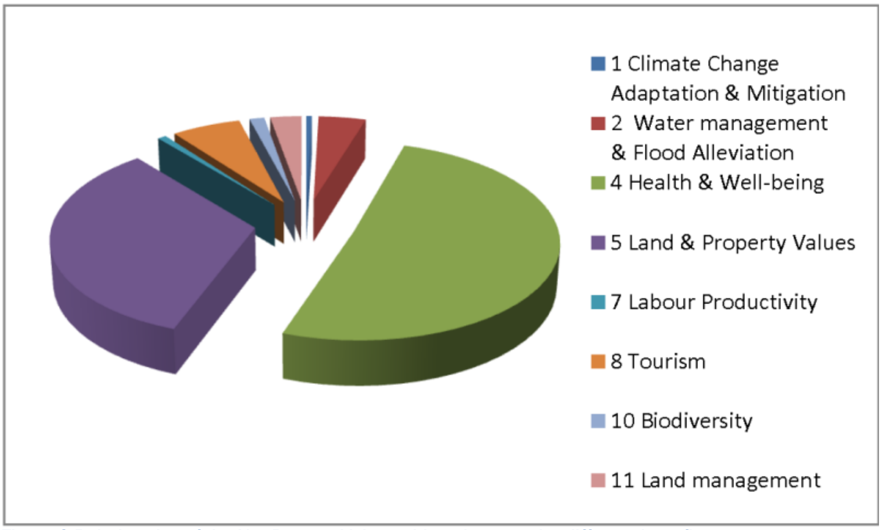

Figure 2 Relative size of the Net Present Value achieved across the different benefit types

Similarly, at Stanley Bank, St.Helens the investment by Heritage Lottery Funding in improving an SSSI and exploring and interpreting the archaeology of the site, was shown to have the potential to deliver £15.2m of economic benefit in addition to the outputs that were required by the funders.

The toolkit was also used to assess the value of Liverpool's green infrastructure, producing an NPV of £8bn.

The toolkit itself recognises the limitations in the evidence base and the need for care to avoid issues such as double counting and ignoring additionality. It does however represent the best tool available at present. It is currently being developed through a PhD project, part of the Centre for Global Entrepreneurship, based at Liverpool University.

Economic value from GI may be delivered in a number of ways;

[26] http://publications.naturalengland.org.uk/publication/32031
Natural England (2012) Microeconomic Evidence for the benefits of Investment in the Environment – review. Natural Englad Research Report NERR033. Available at: http://publications.naturalengland.org.uk/publication/32031

- **Direct** - Direct jobs and business development from the creation and management of green infrastructure
- **Indirect**- Green infrastructure creating the setting for jobs and investments (Quality of Place and Quality of Life)
- **Reducing Cost** - By using a green infrastructure approach as an alternative for instance to traditional "grey infrastructure" approaches
- **Reducing Risk** - Green infrastructure mitigating or adapting an area for a given risk (not just climate change risk)

The logic chain used to describe green infrastructure from type to value is shown in Figure 3. It is possible to trace value delivered from green infrastructure back to a particular type of green infrastructure, but importantly, and in line with our definition of green infrastructure as a system; the relationships between type and function or function and benefits are not merely simple one to one relationships but are more complicated and commonly relationships are "many to many."

Figure 3 Green Infrastructure Logic Chain

From these four elements we can create complex webs, reflecting (partially) the real life systems that exist in the natural environment. The model does allow us to provide information on the functions, benefits and economic value that are being provided in a specific area based on the green infrastructure typology mapping. An example is shown below:

Figure 4 Simple example of the green infrastructure web from type to value[27]

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[27] See 23 (page 24)
Regeneris Consulting (2009) The Economic Contribution of The Mersy Forest's Objective One-Funded Investments. Available at: http://www.merseyforest.org.uk/files/Economic%20Contribution%20report%20and%20appendices.pdf

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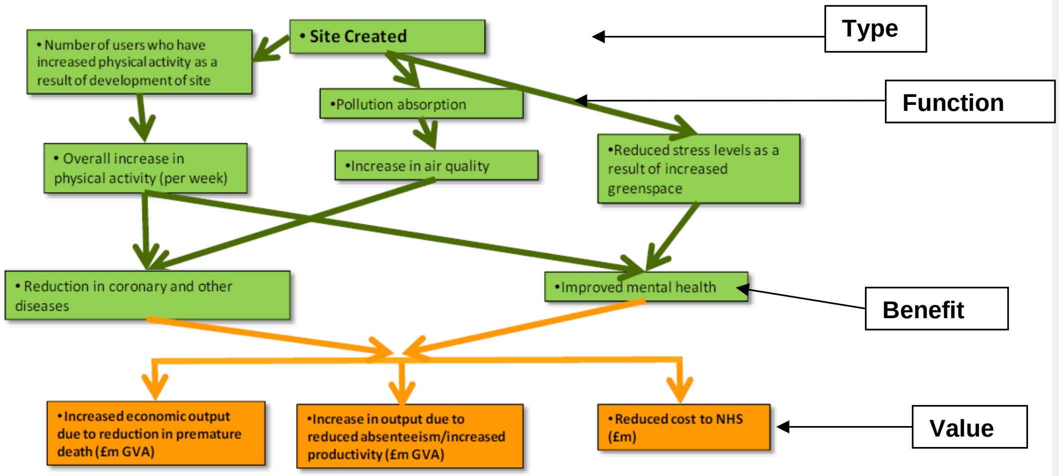
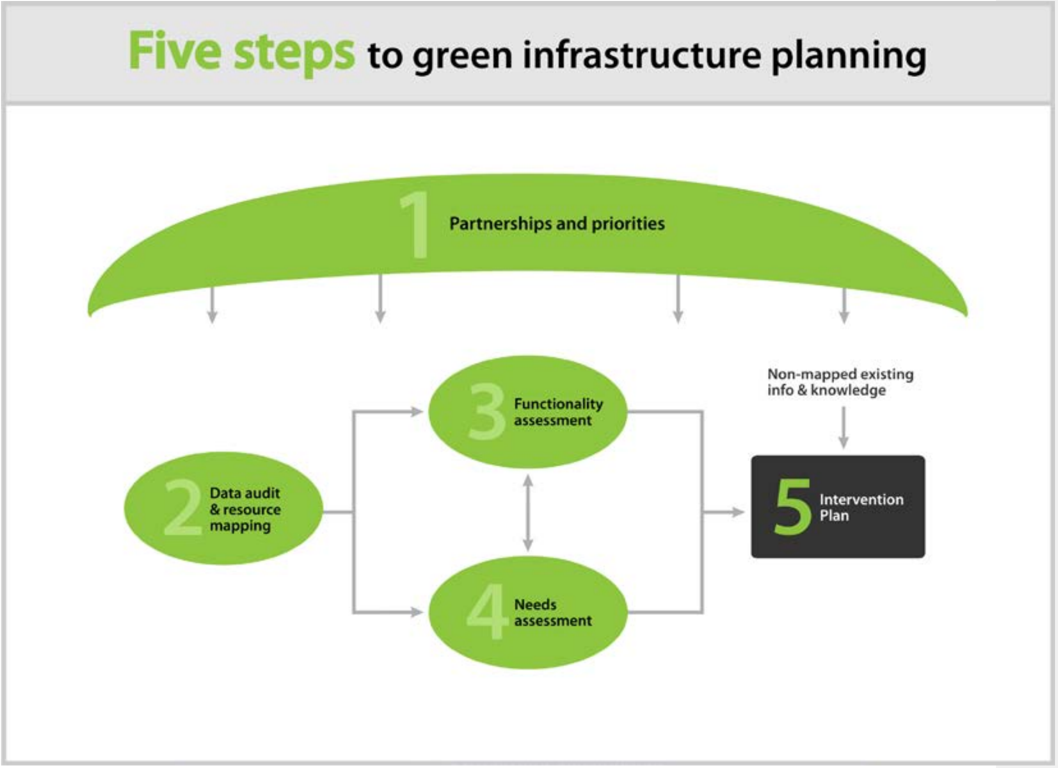

• Site Created
• Number of users who have increased physical activity as a result of development of site
•Pollution absorption
•Increase in air quality
• Overall increase in physical activity (per week)
•Reduced stress levels as a result of increased greenspace
• Reduction in coronary and other diseases
•Improved mental health
•Increased economic output due to reduction in premature death (£m GVA)
•Increase in output due to reduced absenteeism/increased productivity (£m GVA)
•Reduced cost to NHS (£m)
Type
Function
Benefit
Value

9. Green Infrastructure Assessment Methodology

Liverpool City Region Green Infrastructure Framework is based on an established methodology. It consists of five steps (Figure 5).

Figure 5 Five steps to green infrastructure planning.



Step 1 focuses on determining the key priorities, issues, identifying policy support, assembling the evidence base and engaging a range of partners in the development of the framework.

Steps 2 to 4 are mainly concerned with gathering and analysing spatial data to help to understand the issues identified in Step 1 more fully from a green infrastructure perspective. The details of these three steps are provided in Appendix 1.

Finally, **Step 5** develops the recommendations and actions, based on the data, evidence and with stakeholder review. In our case this is the Liverpool City Region Green Infrastructure Prospectus

The five steps are iterative. In particular, the input and feedback from stakeholders and the development of the evidence base informs Steps 2 to 4 and the stakeholder input is vital in developing the intervention plan in Step 5.

10. Context for the Green Infrastructure Framework

The local authorities within the Liverpool City Region and Warrington have a track record of working together in tackling issues that require a cross boundary perspective including, for example, the Local Nature Partnership and the Local Enterprise Partnership.

This section looks at the city region context for the green infrastructure framework, focussing on the following:

- City region policy priorities
- Major economic initiatives with a spatial dimension
- City region spatial character relevant to green infrastructure
- Evolving strategic green space issues within the constituent authorities
- National policy context

City Region and Warrington Policy Priorities

Economic Drivers

The city region economic policy has evolved from the superseded development programme (2005) and Multi-Area Agreement (2009) which articulated five strategic priorities:

- Creative and competitive city region
- Premier destination
- Well-connected city region
- Talented and able city region
- Sustainable communities

The key sectors for growth are:

- Super Port
- Low Carbon Economy
- Knowledge Economy
- Visitor Economy

The key objectives and themes from the Warrington Regeneration Framework (2009)[28] are:

- promoting social inclusion to address the marginalisation of communities and people
- promoting sustainable regeneration through a range of actions and initiatives
- integrating social, cultural, economic and physical regeneration through targeted actions
- harnessing the opportunities and potential that Warrington provides

Co-ordinated programmes of action are being put in place to deliver these priorities including:

Super Port Action Plan-Delivering Economic Growth 2011-2020

Liverpool city region's ports, airport, road, rail and logistics assets provide an established economic basis to take advantage of changing international trends including expanding trade opportunities in China, India and South America and the widening of the Panama Canal. The Super Port Action plan sets out a programme of actions to take advantage of these trends for the benefit of the City region.

Low Carbon Economy Action Plan 2011-2015

The action plan sets out a programme to take advantage of a range of opportunities to reduce carbon emissions such as offshore and onshore wind power, tidal power and biomass.

Liverpool City Region Renewable Energy Capacity Study

This study completed in 2010 will have implications for green infrastructure in particular through the identification of biomass CHP and district heating schemes as one of the best opportunities for renewable energy provision in most of the urbanised areas within the city region.

Liverpool City Region Visitor Economy Strategy to 2020

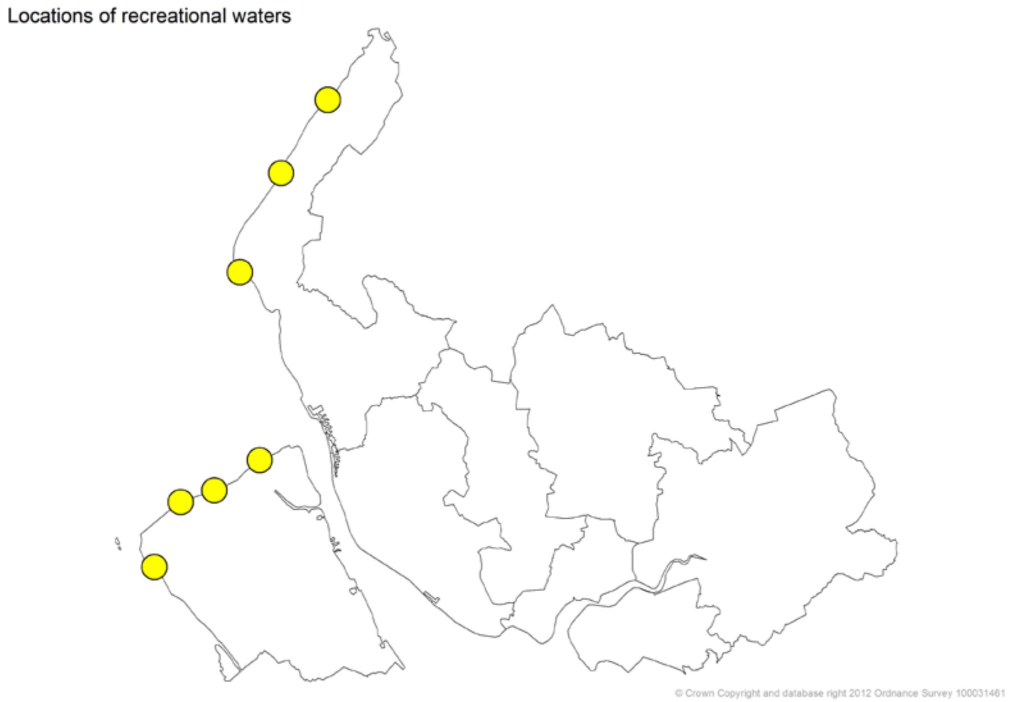
Developing the visitor economy is a key objective for the city region and this strategy produced by the Mersey Partnership in 2009 has six aims including deliver the highest quality experience for our visitors by investing in our public realm, our transport, visitor information and destination welcome. Two of the

[28] http://www.warrington.gov.uk/info/200566/regeneration/791/regeneration_framework

themes for developing are Culture & Heritage and conferences. Specific reference is made to the importance of golf.

The city region coastal areas are already a key tourism destination and have the potential to attract more visitors provided that the quality of the resort and from a green infrastructure perspective the bathing waters are maintained or improved. Projections for climate change suggest that an increased number of visitors from the city region and abroad may look to the coast as places to visit and also to take holidays. The quality of the bathing waters as well as the quality of place more generally will significantly affect how this market develops[29].

Figure 6 Significant bathing waters used for recreation and attracting tourism



The 2006 Climate Change and the visitor economy study highlighted the challenge that climate change will bring for planning and management of some of the key “green” visitor attractions. The study highlights that management of visitor, increasingly looking at outdoor activities to complement the shopping and cultural tourism attraction, will be required to direct them toward areas of greater resilience to both increased numbers of visitors and a changing climate.

Local Enterprise Partnership (LEP)

As from November 2010, the main mechanism for delivering economic development in the City region will be the Local Enterprise partnership (LEP) established to replace the Regional Development Agency. It is envisaged that the Partnership will play an important role in developing the conditions for economic growth and will work with key partners in business, the universities and social enterprises to transform

[29] McEvoy, D., Handley, J. F. Cavan, G., Aylen, J., Lindley, S., McMorrow, J. and Glynn, S. (2006). Climate Change and the Visitor Economy: the challenges and opportunities for England’s Northwest, Sustainability Northwest (Manchester) and UKCIP (Oxford). Available at: www.ukcip.org.uk/wordpress/wp-content/PDFs/CCVE_NW_tech.pdf

the local economy and to determine key priorities for action and investment. The LEP will focus on functions such as key infrastructure projects, housing and transport that will provide conditions for business growth and ensure businesses are supported to deliver their growth ambitions.

Key priorities for action include:

- Accelerating the creation of new business.
- Supporting growth and improving productivity in local small and medium sized businesses.
- Making best use of public sector funds to induce private sector business investment and to maximise private sector leverage.
- Delivering a step change in our economic performance by prioritising our investment activity in transformational areas, such as the Visitor Economy; Knowledge Economy; Liverpool Super Port and the Low Carbon Economy.
- Increasing the number of residents who are in work.
- Increasing the scale of economic activity and developing global markets.
- Working with business to produce a demand led programme of investment in skills and learning.
- Promoting economic growth and meeting the demands of the low carbon agenda.
- Supporting all potential investors with planning, access and infrastructure, sites availability and finance.
- Atlantic Gateway development including Wirral and Liverpool Waters

The LEP recognises that specific economic priorities will require consideration across a broader perspective than the sub-region including the enhancement of the natural environment and resolving emerging pinch points in our critical and green infrastructure.

Warrington, in partnership with Cheshire East and Cheshire West and Chester have also established their LEP. This also recognises the need for proactively engaging with adjoining LEPs on common interests such as Atlantic Gateway and Daresbury Science and Innovation Campus. It also proposes creating the right environment for economic growth including infrastructure provision

Enterprise Zones

Budget proposals in March 2011 included the establishment of Enterprise Zones where tax breaks and fast track planning will be introduced to attract new businesses. Liverpool Waters and Wirral Waters were named as an Enterprise Zone. A second wave was announced in August 2011 including Daresbury Science Campus, Runcorn.

City Region Deal

In July 2012 Liverpool City Region Local Enterprise Partnership (LEP) and partners has negotiated a second City Deal with Government which will bring further investment to the City Region.

The Deal agrees a number of proposals with government covering skills and worklessness, transport, trade and inward investment, low carbon economy as well as harnessing the regions natural assets. The LEP has led the negotiations that have secured the following for the City Region:

- An international Business Festival which showcases and celebrates business opportunities to Europe and the rest of the World, delivering £100m return on investment
- To increase employment by combining £81m public and private employment and skills investments and empowering businesses to create more jobs, tackle skills gaps and raise productivity, supporting 17,400 people into work and creating 6,000 apprenticeships
- To put transport at the heart of economic development through a revised approach to governance and creation of a joint investment fund of £800m supporting the creation of 15,000 jobs
- To harness the City Region's science and knowledge assets, attracting 'big science investment', increasing GVA and generating 2,000 high value jobs

- A low carbon red tape pilot that will aim to reduce regulatory burdens and streamline local planning process to accelerate over £100m worth of investment in offshore wind infrastructure in the City Region and create 3,000 jobs
- To examine how the River Mersey can become the cleanest river in an urban setting by 2045, with the commensurate economic benefits.[30]

Warrington

Warrington is about to publish its Regeneration Framework to update the current document.

Areas that are likely to be a priority include

- Warrington Town Centre
- The Omega site
- Warrington Waterfront
- Mersey Valley Forest Park

The final version of the GI Framework will be able to provide the most up to date list of sites and the updated strategic priorities.

Other Drivers

Liverpool City Region Housing Strategy

The City Region Housing Strategy is a collaborative project between all thirteen local authorities in the sub-region, New Heartlands and a range of public and private stakeholders. The strategic objective is to ensure sufficient quality, and choice of aspirational and affordable housing options that support the economic growth agenda of the City Region Development Plan.

Development of the strategy will include making linkages with other associated agendas including health, green space, highways and community cohesion.

Third Local Transport Plan

There are separate Local Transport Plans for Merseyside[31], Halton[32] and Warrington[33], though Halton and the rest of Merseyside have now formed a single Local Transport Body (LTB).

The third Merseyside Local Transport Plan covers the period to 2024. This sets out the following vision for the transport network:

"A city region committed to a low carbon future, which has a transport network and mobility culture that positively contributes to a thriving economy and the health and wellbeing of its citizens and where sustainable travel is the option of choice."

A number of actions are identified which include those demonstrating a clear relationship between transport and green infrastructure. These are particularly relevant in relation to walking and cycling and their contribution to the health agenda.

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30 liverpool.gov.uk/news/details.aspx?id=216961 Liverpool City Council (2012) City region deal with government.
31 http://www.letstravelwise.org/files/1296228986_Summary%20(lo%20res).pdf
32 www3.halton.gov.uk/transportandstreets/transportpolicy/
33 http://www.warrington.gov.uk/info/200526/transport_planning_and_policy/700/local_transport_plan_3

Through the Local Sustainable Transport Fund funding has been secured between 2011 and 2014/15 to support a range of projects including opportunities to increase green infrastructure linked to sustainable transport solutions.

Covering a similar timescale the Local transport plans for Halton and Warrington also emphasise sustainable modes of transport, and at the sub-regional scale include the Mersey Gateway Project and expansion plans for Liverpool John Lennon Airport.

Mersey Forest Plan

The Mersey Forest is a government approved community forest extending over 465 square miles of the sub-region with its delivery guided by the Forest Plan approved initially in 1994, updated in 2001 and refreshed 2012.

The vision is

"To deliver "More from Trees"
Transforming our landscape, creating 8,000 hectares of new woodland, planting urban trees and managing woodland in and around our towns and cities, involving partners and communities, to provide economic and social benefits from environmental regeneration."

Working with the key local authority partners of Liverpool, Sefton, Knowsley, St.Helens, Halton, Warrington and West Cheshire and Chester the Mersey Forest Team has been successfully implementing the Plan, delivering environmental, economic and social benefits to local people through the creation of community woodland.

Woodland cover since 1994 has been increased by 72%[34], 64% of people say that they have seen a positive improvement in their environment and 22% say that they use their local community woodland at least once a week[35].

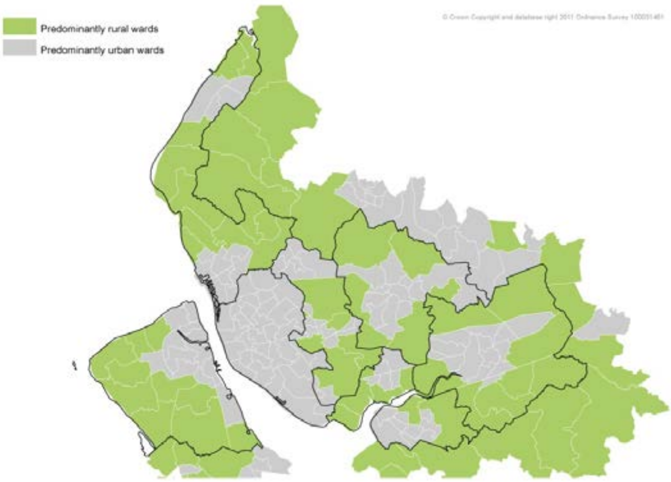
Rural Economy Strategy

In late 2009, Green Zone: An economic Strategy for Rural Merseyside[36] was published. This carried out an analysis of the rural economy and identified that:

- It covers 58% of the land area
- Rural area accounts for 22% of Merseyside's total GVA.
- GVA per worker is higher in the rural area than in urban Merseyside.
- in rural GVA (10.9%) virtually matched growth in urban GVA (12.3%) and in some districts exceeded it
- It has some major tourism brands and visitor destinations – Sefton's Natural Coast, Wirral Peninsula, Southport England's Classic Resort, Knowsley Safari Park and England's Golf Coast.
- Its farming and land based sector produce distinctive local food
- It maintains an extensive network of green infrastructure including the Merseyside Green Belt.
- Its towns and villages host a diverse and vibrant retail sector and provide services which underpin the quality of life of for in the region of 400,000 people.

[34] http://www.merseyforest.org.uk
[35] Vision 21 (2010) Mersey Forest Awareness Survey. Overview available at: http://www.merseyforest.org.uk/partnerreports/awareness_survey2010.pdf
[36] Rural Innovation and Centre for International Competitiveness (2009) Green Zone 2025. An Economic Strategy for Rural Merseyside. Available at: www.wirral.gov.uk/downloads/881.

Map 2 Rural City Region



The strategy builds on the success of previous rural development projects such as the Integrated Countryside and Environment Plan (ICEP) and the successor Merseyside Rural Leader programme that will run to 2015.

Table 4 Mersey Rural Leader Themes for Support

Themes	Description
Support Merseyside	The continued support to enable a broad reaching support to different producer sizes and points in the supply chain.
Equine Business	The equine industry is vastly important to the sub region with support and assistance required at different levels of intervention.
Sustainable Biomass	Arboriculture waste, the management of existing woodland can be significant in producing a renewable green source of heat for different sizes of applications.
Energy and Resources	Constant pressure from legislation, economic policy and dwindling resources has pushed this to the top of most people's development agendas. Eligible businesses will be able to access funding to have an audit prepared for their current position and to access potential areas of savings.
Retail	Empowering rural retails to sell and maximise on their unique selling points to enable them to compete on a higher, differentiated level, taking advantage of local markets and the opportunities to add value to products.
Tourism and Attractions	As more people look closer to home for relaxation and leisure the massive potential of the green infrastructure and a large population are clear for any developer to realise the potential.

Major economic initiatives with a spatial dimension

Economic Priority Areas

The following are strategic initiatives referred to in the City Region Multi Area Agreement and City Region Development Plan. They are also shown in Figure 8 Atlantic Gateway Priority Projects (in red);

- Liverpool City centre including Liverpool One
- Southport Classic Resort
- Mersey Waterfront Regional Park
- Mersey ports including Mersey Multi –Modal Gateway (3MG) and SFRI Parkside
- Liverpool John Lennon Airport
- Mersey Gateway
- Liverpool and Wirral Waters
- Daresbury Science and Innovation Centre
- Liverpool Science Park
- Liverpool Knowledge Quarter
- Liverpool Waterfront
- Mersey Tidal Energy Project
- New Heartlands HMRI
- Eastern Approaches[37]
- Omega
- Strategic Investment Areas:
- Liverpool City centre
- Eastern Gateway
- International Gateway (Speke/Halewood)
- Northshore (formerly Atlantic Gateway)
- Approach 580 Gateway (A580 corridor in Knowsley and Liverpool and includes Knowsley Industrial Park)[38]
- Wirral waterfront
- St Helens Regeneration Corridor
- Huyton-Prescot

Atlantic Gateway

The Atlantic Gateway is a framework for collaboration between the Manchester and Liverpool city regions which will help to unlock their full sustainable economic growth potential. The city regions extend beyond the administrative boundaries of Greater Manchester and Merseyside to include the wider shared hinterland of both city regions across Warrington, Halton, Chester and northern Cheshire.

The Atlantic Gateway Business Plan[39] sets out a vision for £14bn of new investment generating 250,000 new jobs in the area by 2030.

[37] www.liverpoolvision.co.uk/A_Changing_City/Eastern_Approaches.aspx
[38] www.liverpoolvision.co.uk/A_Changing_City/Approach_A580_Gateway.aspx
[39] www.atlanticgateway.co.uk

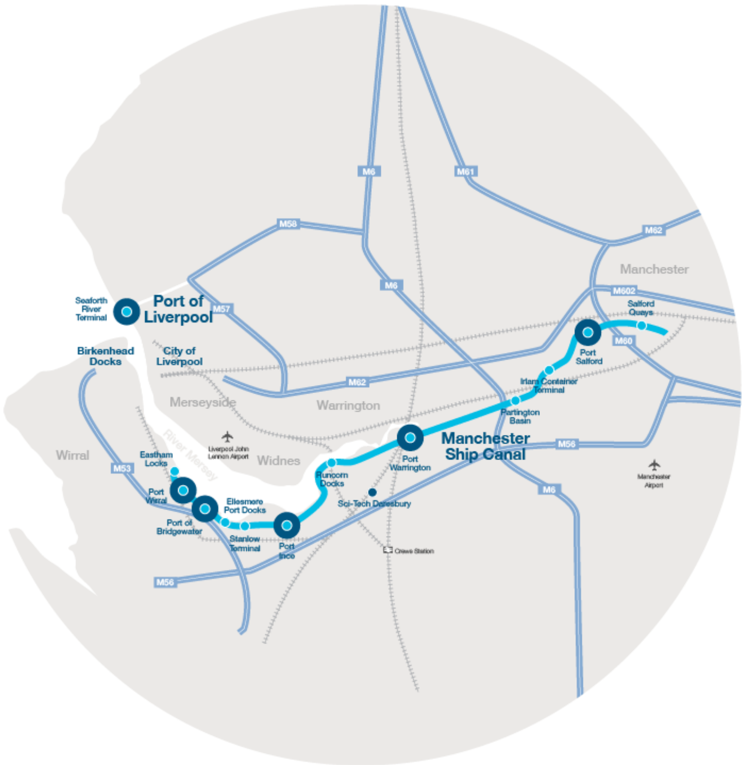


Figure 7 Atlantic Gateway[40]

The connected economic geography, with overlapping labour and housing markets, provides a unique opportunity for the Atlantic Gateway to become one of Europe's leading low carbon, economic growth areas – second only to London within a UK context.

Figure 8 shows the location of the Atlantic Gateway priority projects.

[40] Source: http://www.atlanticgateway.co.uk/

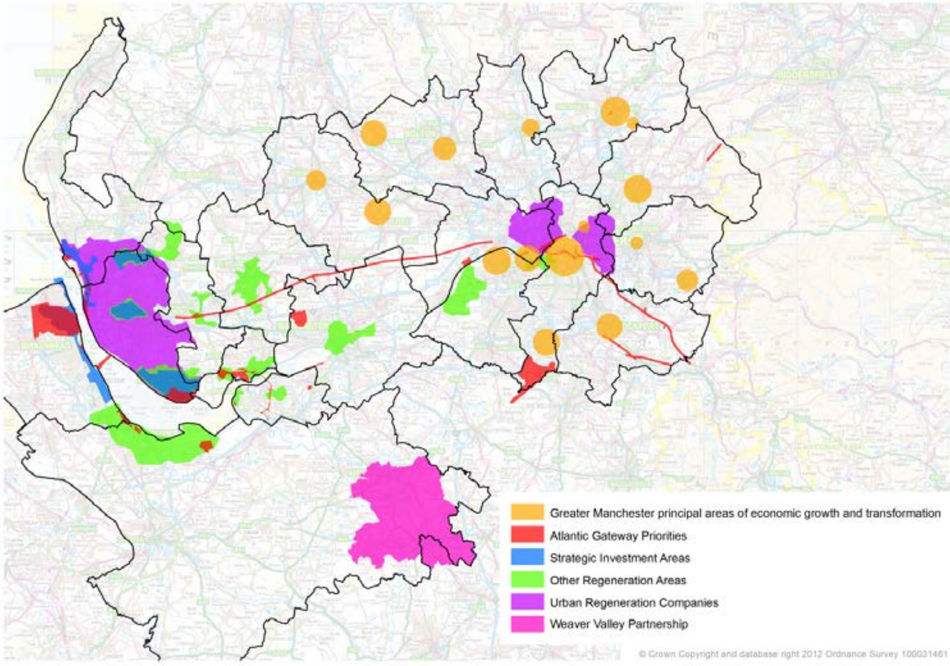


Figure 8 Atlantic Gateway Priority Projects (in red)

Adapting the Landscape

As part of Atlantic Gateway, research was commissioned to look at the landscape context of the Liverpool to Manchester corridor. The report "Adapting the Landscape" [41] sets out a vision for the lower Mersey Basin.

"The vision is of a more productive, playful and engaging landscape that is a playground for the people, an axis of innovation connecting our two city regions and a living, breathing, sustainable 'bioregion' that produces food, generates energy and helps us to tackle the critical issue of climate change."

Green infrastructure and delivery mechanisms, such as community forests, are seen as important elements of the potential future development of the project.

"Greening the city with tree planting and urban woodlands, green roofs, allotments and community gardens. This would build off of existing resources and efforts, such as Red Rose Forest in the Greater Manchester area and Mersey Forest in the Liverpool area, which are the two largest community forests in England."

Liverpool and Wirral Waters

The largest and most ambitious regeneration project within the city region is proposed for former dockland areas on both the Liverpool and Wirral banks of the Mersey. Both projects are promoted by Peel Holdings and were designated as an Enterprise Zone in the Budget in March 2011.

Liverpool Waters involves the investment of £5.5 billion to regenerate a 60 hectare historic dockland site creating a world class, high quality, mixed use waterfront quarter in central Liverpool. The scheme

[41] Adapting the Landscape, URS, NWDA, 2009 URS and NWDA (2009) Adapting the Landscape from Liverpool to Manchester. Research description available at: http://www.ursglobal.com/projects/project.php?project_id=831

will create a unique sense of place taking advantage of the sites cultural heritage. It will contribute substantially to the growth and development of the city, allowing ease of movement and strong connections between Northshore, its hinterland and the city centre. A planning application was submitted in October 2010.

The Wirral Waters scheme was granted planning permission in August 2010.It represents an investment of £4.5 billion and comprises a mixed use development including 20,000 jobs in a broad range of commercial uses and over 13,000 new homes.

Integration of both projects into existing urban development including the green infrastructure framework will be a key consideration.

North Liverpool and South Sefton Regeneration Strategy

A 20 year plan to revitalise North Liverpool and South Sefton was launched in June 2011. It aims to attract investment and improve the deprived wards of Anfield, County, Everton and Kirkdale including actions to deliver the following vision:

'To create a renewed sense of purpose and identity, to create a thriving place with a sustainable economic purpose ready for investment and development of new business, residential environments and riverside uses. It will be a community of green suburbs nestled between gardens and parks, overlooking the river, linked to the city in the south and the countryside in the north.'

As part of the Strategic Regeneration Framework, GreenPrint for Growth is a green infrastructure strategy that has been developed for the area to coordinate investment and maximise the benefits to jobs and business of a well-planned and managed green infrastructure[42].

[42] http://www.liverpoolvision.co.uk/news/greenprint_for_growth.aspx

City Region Spatial Character

Natural England is in the process of publishing detailed landscape character assessments. These will provide a context for assessing development and policy development including the Green Infrastructure Framework and its delivery.

The following character areas summarised are relevant to the study area

- Sefton Coast
- West Lancashire Plain
- Liverpool conurbation
- The Wirral
- Mersey Estuary
- Mersey Valley Lancashire Coal Measures
- North Cheshire Plain

A wealth of information on each character areas is available at -
www.naturalengland.org.uk/publications/nca/northwest.aspx

Landscape character forms a crucial guide along with the biodiversity action plans and ecological framework in the physical delivery of green infrastructure projects.

Hydrology

The city region is dominated by the River Mersey and estuary. Rivers flowing into the Mersey from the north include the Ditton, Sankey and Glaze Brooks; from the south the Weaver navigation; whilst the Alt and Crossens flow westwards into the estuary. On the Wirral the Dee Estuary forms the western edge with the Birket and Dibbinsdale Brook flowing east into the Mersey. The Manchester Ship Canal is an important feature in the sub-region helping in the drainage and reduction of flood risk, particularly in Warrington and Halton. Much of this catchment is low lying with the Alt and Crossens in particular, being reliant on pumping stations at Altmouth and Crossens for discharging into the Mersey.

The Environment Agency has prepared Catchment Flood Management Plans setting out policies for managing flood risk. The plans relevant to the Liverpool City Region are the Mersey Estuary, Alt/Crossens and to a lesser extent the Weaver/Gowy.

There is considerable potential to integrate policies for flood management and green infrastructure. For example proposals in the Catchment Flood management plans include: the long term protection and recreation within watercourse corridors and floodplains through sustainable land use management; investigating the feasibility of flood water storage in the middle and upper Alt and Upper and Middle Sankey. A Knowledge Transfer Partnership with a range of partners involved alongside WaterCo and the University of Liverpool are currently exploring opportunities for green infrastructure approaches to managing flood risk in the Sankey Valley area of St Helens.

A Shoreline Management Plan has also been prepared which is concerned with flood protection and requirements for coastal defences. For the Liverpool City Region sections of coastline the main emphasis is on maintaining flood defences and natural processes such as the Sefton sand dunes.

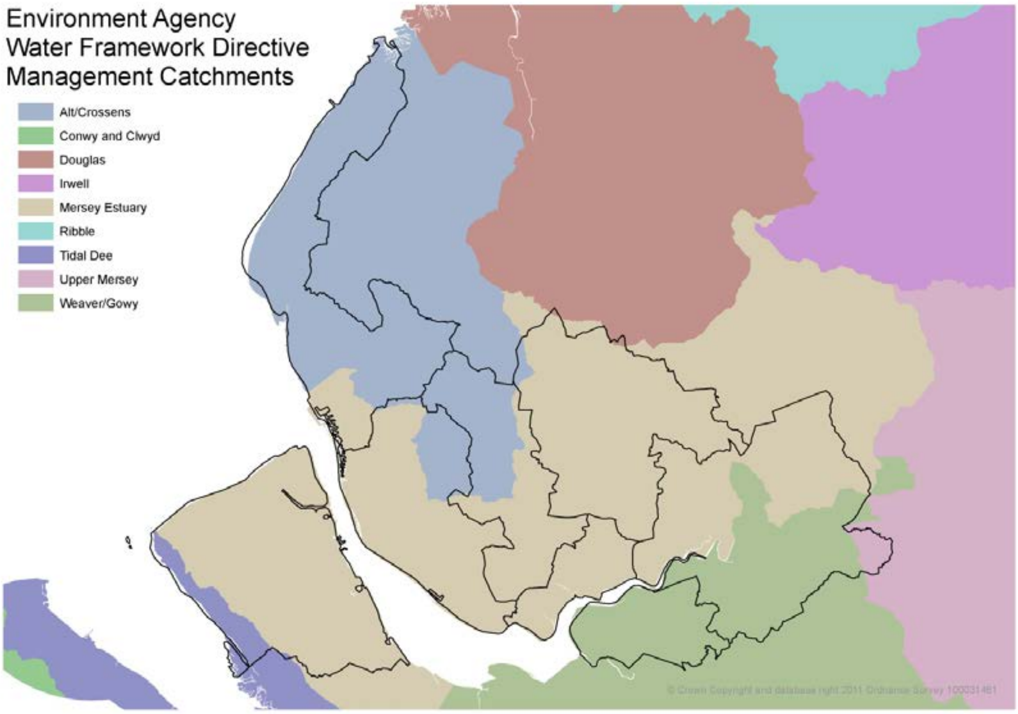


Figure 9 EA Water Framework Directive Management Catchments

The Water Framework Directive provides the overall context for policy and action that safeguards and enhances:

- Natural Water Bodies
- Artificial Water Bodies
- Heavily Modified Water Bodies

These water bodies include the following types:

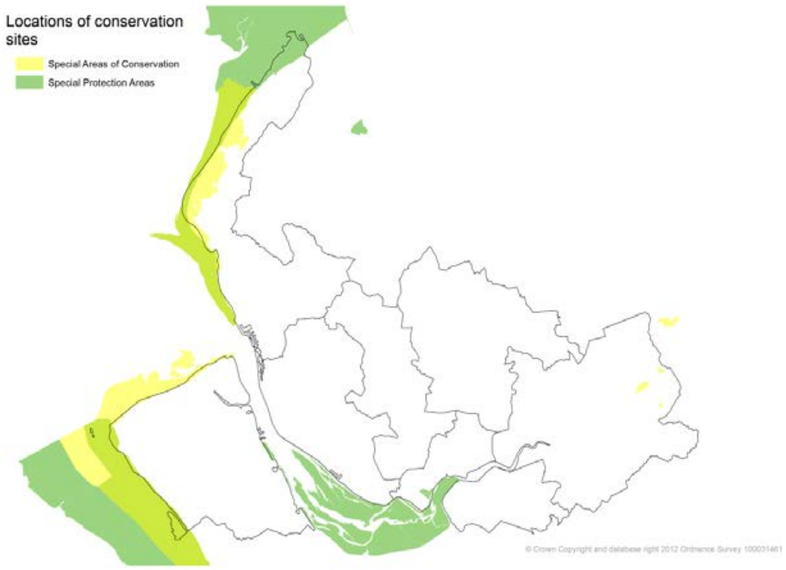
- Rivers, canals and surface water transfers
- Lakes and Reservoirs
- Estuaries
- Coastal
- Groundwater

The Water Framework directive sets a target to achieve at least "good status[43]" in all water bodies by 2015 and also brings together the planning processes of a range of other EU Directives. Table 5 shows the number of the EU Directive areas in the City Region and Warrington.

[43] Good status is defined for each of the water body types. Environment Agency (2009) River Basin Management Plan, Northwest River Basin District, (main document). Available at: http://www.environment-agency.gov.uk/research/planning/124837.aspx

Table 5

Directive	Protected Area	Number of protected areas in City Region and Warrington
Bathing Waters	Recreational waters	7
Birds	Natura 2000 sites (water dependent special protection areas)	3
Freshwater Fish	Waters for the protection of economically significant aquatic species	22
Shellfish Waters	Waters for the protection of economically significant aquatic species	4
Habitats	Natura 2000 sites (water dependent)	4
Nitrates	Nitrate Vulnerable Zones	5
Urban Waste Water Treatment	Sensitive Areas	4



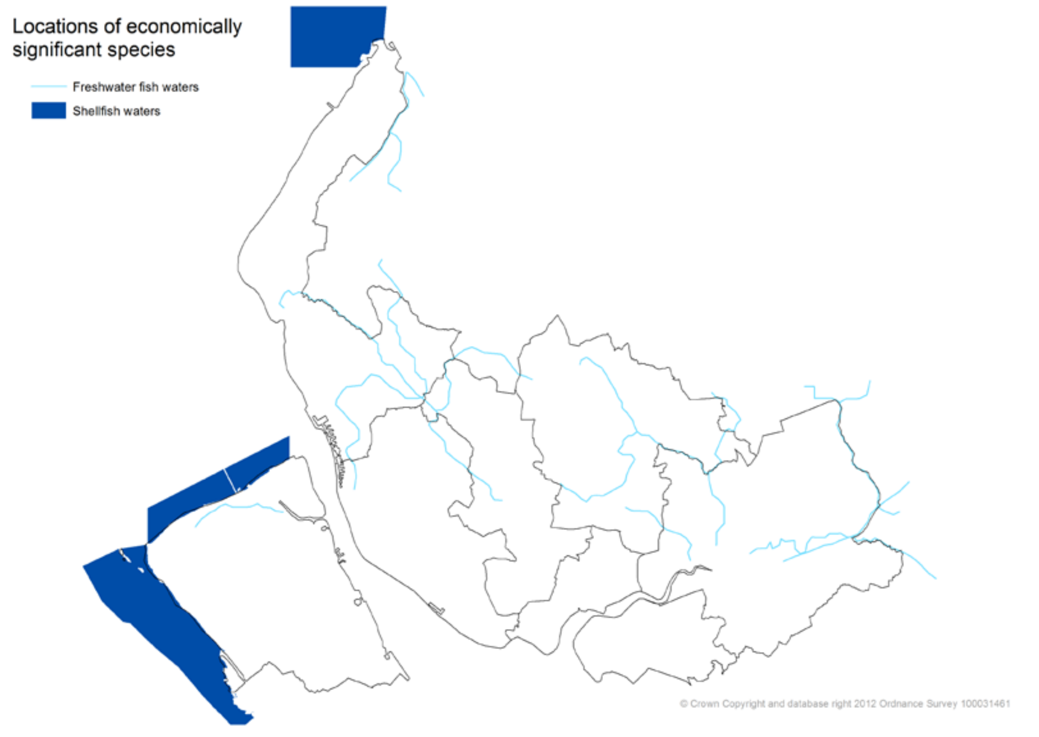
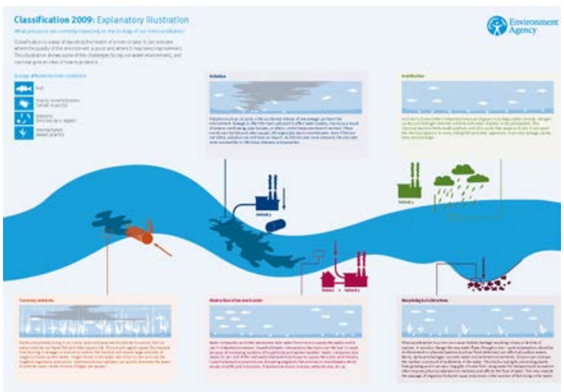


Figure 7 taken from the *"Living Waters"* document provides an overview of the pressures that impact upon rivers and lakes and which can cause these waters to fall below targets set out in the Water Framework Directive. The aim of GI Planning is to identify ways to reduce these pressures through change in land use or altering land use management.

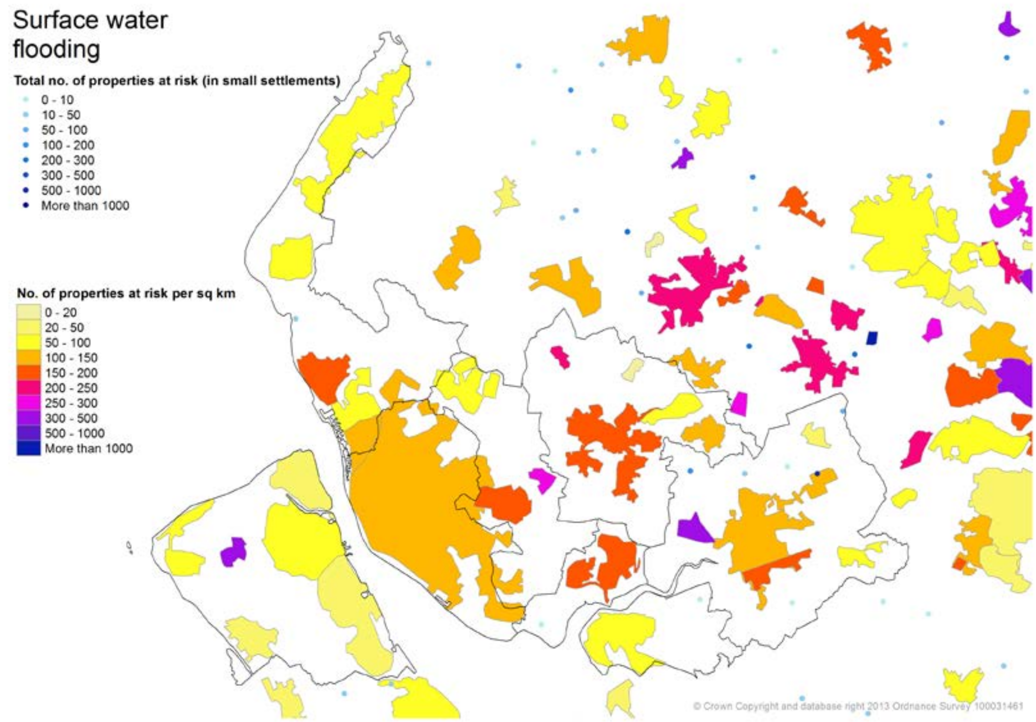
Figure 10 Overview of pressures on rivers and lakes[44]



[44] Source: www.informsystem.com/livingwaters/eng/pdf/What_pressures_illustration.pdf

In addition to coastal and riverine flooding under the new Flood Regulations local authorities as the Lead Local Flood Authority are required to produce Surface Water Management Plans (SWMP). SWMPs establish long-term action plans to manage surface water and will influence future capital investment, maintenance, public engagement, land-use planning, emergency planning and future developments. The SWMP provides a tool for spatial planners to incorporate surface water flood risk into planning policy and development control. The following map shows where properties are at risk from surface water flooding.

Map 3 Surface water flood risk



In Sefton for example green infrastructure has been identified as one opportunity to help reduce flood risk.

"A draft Climate Change Adaptation Plan[4] is available for Sefton Metropolitan Borough Council, which identifies flooding as one of the key risks associated with climate change. Risks were identified to assets (buildings and infrastructure), to the environment, to the councils ability to deliver services and of additional demand for resources and services. Opportunities were identified for reducing flood risk by increasing green infrastructure.[45]"

45 Sefton Metropolitan Borough Council (2011) Preliminary Flood Risk Assessment. Preliminary Assessment Report. Available at: http://publications.environment-agency.gov.uk/PDF/FLHO1211BVVI-E-E.pdf

A new draft Water Bill was published in 2012[46]. It looks at securing sustainable and resilient water supplies to 2050. It highlights the value of the catchment approach to addressing water quality issues.

[46] http://www.official-documents.gov.uk/document/cm83/8375/8375.asp

Biodiversity and the City Region Ecological Framework

As described in Section 8 above, green infrastructure planning aims to maximise functionality of the natural environment to meet identified needs. There should therefore be significant opportunities for biodiversity enhancement across all green infrastructure projects and programmes.

Along with landscape character improvements, achieving biodiversity gains should be a goal of any green infrastructure project.

The recent TCPA and The Wildlife Trusts publication "Planning for a healthy environment - good practice guidance for green infrastructure and biodiversity[47]" set out the policy framework and also a range of examples of how biodiversity can be achieved through green infrastructure project delivery.

The 2012 Merseyside State of the Environment Report[48] indicates that

- 350 Local Wildlife Sites have been designated in the Liverpool City Region,
- The percentage of Local Wildlife Sites in Active Conservation Management has increased to 29.4% (2009/10) from 28.2% (2008/9)
- Since 2005 no sites have been lost due to development or for other reasons but continued management is a key issue.

The report also indicates that the city region did not achieve the national target for SSSIs to be in favourable or recovering position by 2010; however the target was missed by just 1.1%.

In Warrington there are 40 sites listed "Sites of Interest for Nature Conservation"

DEFRA are currently revising the datasets used for national sustainability indicators. In the past these have included farm and woodland bird populations as well as land use and fish stocks. Whilst Merseyside Biobank and the Cheshire and Warrington Record Centre have a wealth of information on habitats and species in the city region and Warrington, we have not been able to find data to give an overall picture of the loss or gain of biodiversity.

This Green Infrastructure Framework falls into two Biodiversity Action Plan areas

- North Merseyside[49] (Liverpool, Sefton, Knowsley, St.Helens)

In our vision Merseyside is a place where biodiversity flourishes; where everybody helps to nurture and enhance our biodiversity; and where biodiversity is a natural consideration in policies and in society as a whole.

- Cheshire[50] (Wirral, Halton and Warrington)

Our vision is a Cheshire region richer in wildlife; a place where biodiversity flourishes, where everybody helps to nurture and enhance our biodiversity, and where biodiversity is a natural

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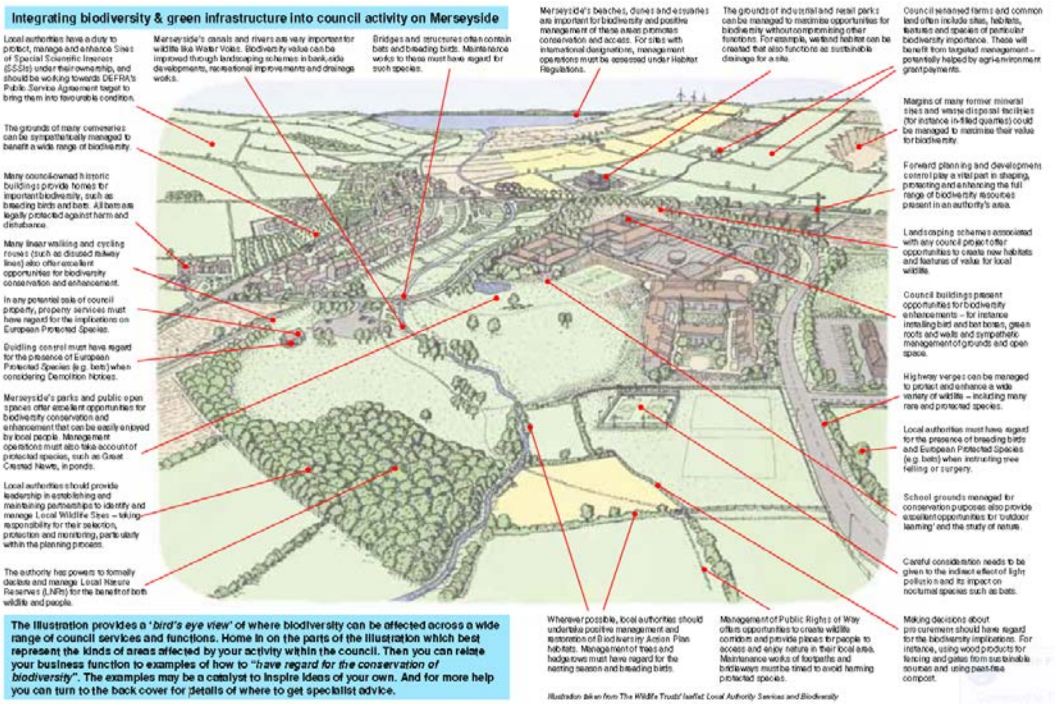
[47] TCPA, Town & Country Planning Association and The Wildlife Trusts (2012, planning) Planning for a healthy environment – good practice for green infrastructure and biodiversity. TCPA, London. Available at: http://www.tcpa.org.uk/data/files/TCPA_TWT_GI-Biodiversity-Guide.pdf
[48] Mott Macdonald (2011,) State of the Environment Report, MEAS
[49] www.merseysidebiodiversity.org.uk/
[50] www.cheshire-biodiversity.org.uk/

consideration in policies and in society as a whole.*

Biodiversity Action Plans (BAP) set targets for the maintenance, restoration and expansion of locally occurring UK Priority Habitats, including through the delivery of green infrastructure projects (see Figure 11 Opportunities to enhance biodiversity, for some examples).

Figure 11 Opportunities to enhance biodiversity[51] (update/revise)



Amongst the wide range of BAPS, North Merseyside has a specific Urban Green Infrastructure HAP[52] that identifies a number of important sites for biodiversity enhancement within urban areas.

The emergence of green infrastructure as a way of thinking cohesively about planning for natural spaces and natural elements within and between our towns and cities presents an important opportunity for the conservation of urban biodiversity. The key to realising this opportunity is to capitalise on green infrastructure's multi-functional approach.

The BAP also sets out a number of targets for urban biodiversity improvements through green infrastructure planning and delivery, for example,

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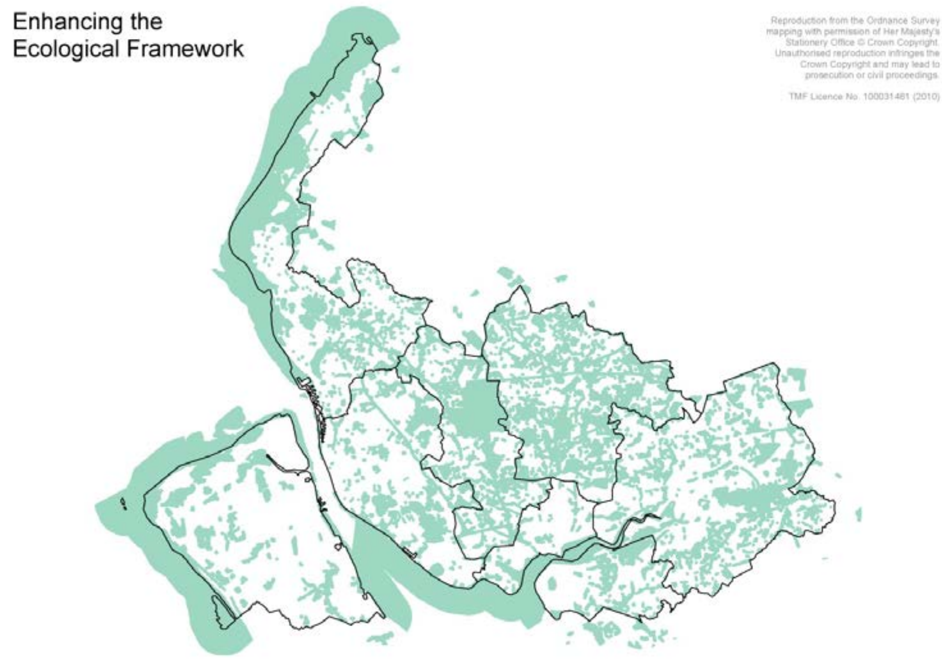
[51] Merseyside Biodiversity Partnership (2006) Merseyside Local Authorities & the Biodiversity Duty. Available at: http://www.merseysidebiodiversity.org.uk/pdfs/MerseysideBiodiversityDuty.pdf

[52] North Merseyside Biodiversity Action Plan. Urban Green Infrastructure. Available at: http://www.merseysidebiodiversity.org.uk/pdfs/Urban%20GI%20HAP.pdf

Text	Date	Quantity
Ensure that significant biodiversity gains are built into the design and implementation of five SuDS by 2015.	2015	5
Ensure that each of the NM LAs has a computerised tree management system by 2015.	2015	4
Ensure that the four NM LAs each have a comprehensive SPD relating to street trees, bushes and shelterbelts. Ensure these promote a net gain in tree canopy cover and the use of appropriate species.	2015	4

Merseyside Environmental Advisory Service has prepared the Liverpool City Region Ecological Framework[53].

Figure 12 - Liverpool City Region and Warrington Ecological Framework



The Ecological Framework aims to reduce the fragmentation or loss of important habitats across the City Region. The Framework has identifies four key elements.

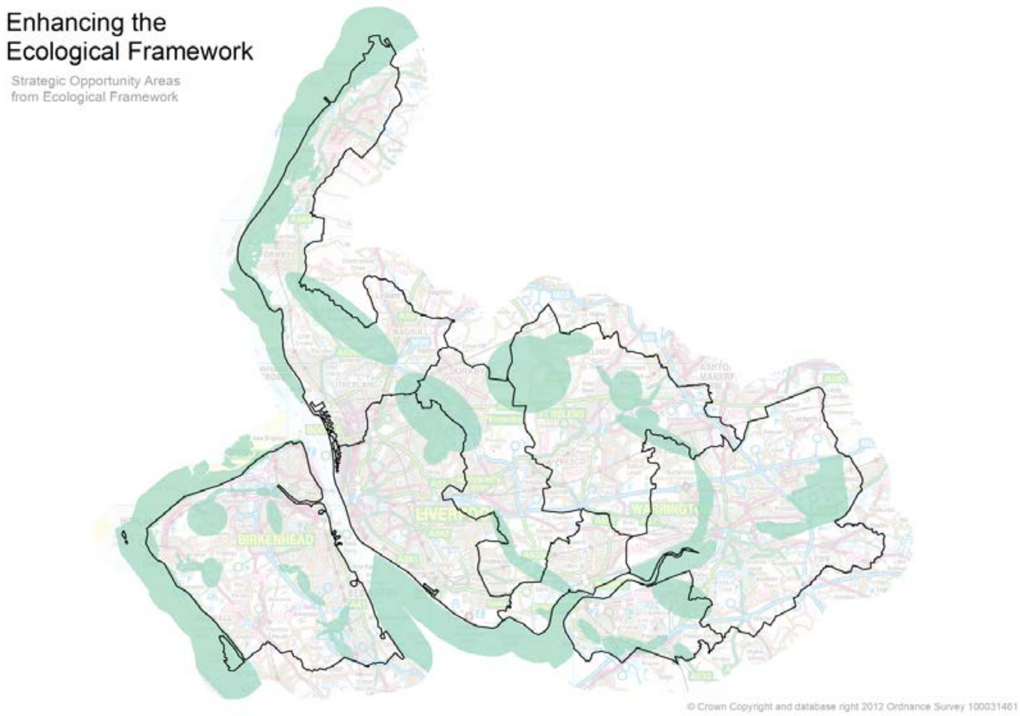
- Core Biodiversity areas – These are locally or nationally designated sites for biodiversity.
- Search Areas for Potential Habitat Expansion – identifying the areas of greatest potential for improving the ecological network. Importantly it is an area of search for opportunities rather than a designation itself.
- Connectivity Zone – again is an area of search for opportunities to connect core biodiversity areas.

[53] www.sefton.gov.uk/default.aspx?page=11542

- Linear Feature – these areas already provide vital links between important areas for biodiversity, but may not themselves be designated nor a priority habitat.

The Core Biodiversity Areas cover 33% of the city region.

Priority attention is focussed on eighteen Strategic Opportunity Areas including:
- Sefton Coast (including Ribble and Alt Estuaries)
- Mersey Estuary
- Dee Estuary
- North Wirral coast
- River Alt Corridor (Little Altcar to Sefton Meadows)
- River Alt, Kirkby Brook, Knowsley Brook, Croxteth Brook and Croxteth park Corridor
- Simonswood Moss, Kirkby Moss, Kings Moss and Holiday Moss
- Blackbrook, Stanley Bank and Carr Mill Dam
- Sankey Valley Corridor
- Netherley Brook and Ditton Brook Corridor
- Bridgewater Canal, Halton Moss and Keckwick
- Dibbinsdale and Raby Mere
- Birket Catchment

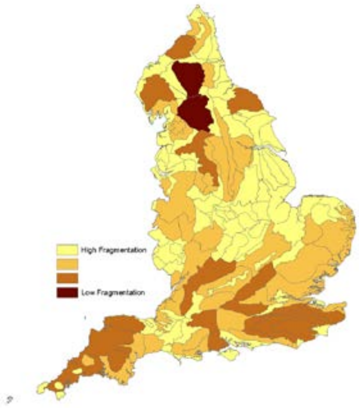


From a national perspective Liverpool City Region has a fragmented ecological network, with woodland seen as being the only terrestrial habitat that comes close to achieving good connectivity[54]. The City

[54] Catchpole, R. (2007) England Habitat Network. Briefing Note, Natural England. Available at: http://www.rogercatchpole.net/index_htm_files/Catchpole,%20R.D.J.%202007%20-%20England%20Habitat%20Network%20Information%20Note..pdf

Region Ecological Framework identifies areas where buffering and increasing scale and connectivity of the network can be improved – in line with the Lawton report (see reference below).

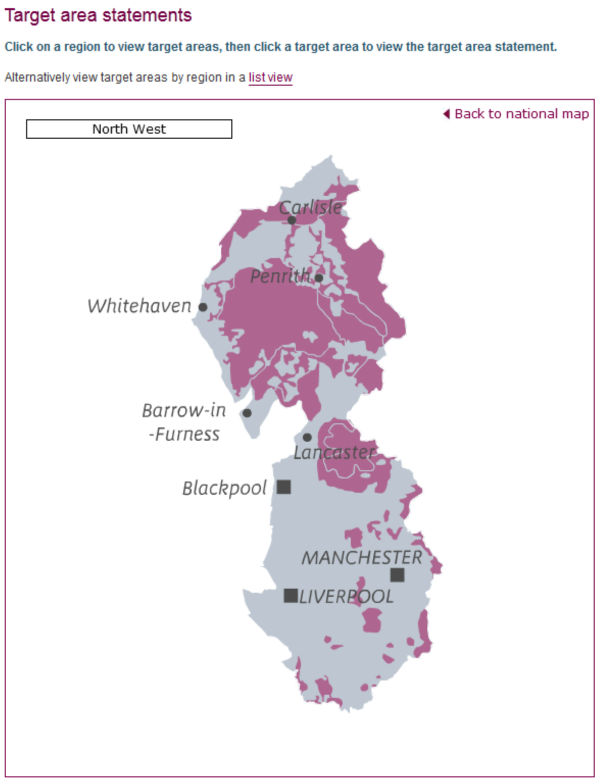
Figure 13 **Levels of habitat fragmentation across National Character Areas.**
Extract from Making Space for Nature - This analysis takes account of habitat extent and permeability land between habitat patches to produce a ranking from areas where habitats are most fragmented (lighter) to less fragmented and more connected (darker). From a new analysis carried out by Dr. R. Catchpole, Natural England.



Through the Rural Development programme for England, significant resources are provided to land owners for environmental stewardship.

Through the Higher level Scheme landowners in 110 areas across England can receive funding for a range of management to improve wildlife, landscape, the historic environment and resource protection.

Figure 14 Areas of North West England with HLS target Statements[55]



Whilst applications for HLS are accepted from outside of target areas, shows that only a small area on the eastern edge of Warrington is currently a target area with statement setting out the key environmental improvements that Natural England are seeking to achieve.

The Entry Level Scheme also aimed at farm owners is a voluntary, non-competitive scheme to deliver effective environmental management. Five-year agreements are available with monthly start dates and automatic payments sent out every six months. The scheme requires a basic level of environmental management and participants can choose from a wide range of more than 50 management options. These cover all farming types and include things such as hedgerow management, stone wall maintenance, low input grassland, buffer strips, and arable options.

Both Entry and the Higher Level Scheme are administered by Natural England.

The Forestry Commission operate the England Woodland Grant Scheme. The scheme is governed by the UK Forest Standard[56] and can assist with funding for woodland creation and a range of management options including habitat improvement for woodland birds.

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[55] http://www.naturalengland.org.uk/ourwork/farming/funding/es/hls/targeting/default.aspx (accessed 10th September 2012) Natural England (2008) North West: Higher level Stewardship Theme Statement. Available at: http://www.naturalengland.org.uk/Images/northwest_tcm6-6473.pdf

[56] Forestry Commission (2011) The UK Forestry Standard. The governments' approach to sustainable forest management. Forestry Commission, Edinburgh. Available at: http://www.forestry.gov.uk/theukforestrystandard

The UK Forest Standard has specific provision for Forests and Biodiversity.

Population Change

Over the next 20 years it is anticipated that the population of the city region will increase by 1.7m people. Table 6 shows the projected in population between 2008 and 2024, whilst Maps (add) indicate the potential spatial distribution of population growth. These projections may require updating based on the latest census data and the changed economic conditions since the data figures were complied.

For this framework we are interested in identifying needs not just for the current population, but also taking in projected population growth - as we are doing for projected climate change and changes to public health.

Increasing population puts pressure on existing grey and green infrastructure. For example, increased population may lead to increased levels of car ownership and pressure for parking areas, potentially sealing surfaces, leading to increased water run-off and pressure on surface water drains. Increased population will also "need" high quality areas of open space for recreation and leisure.

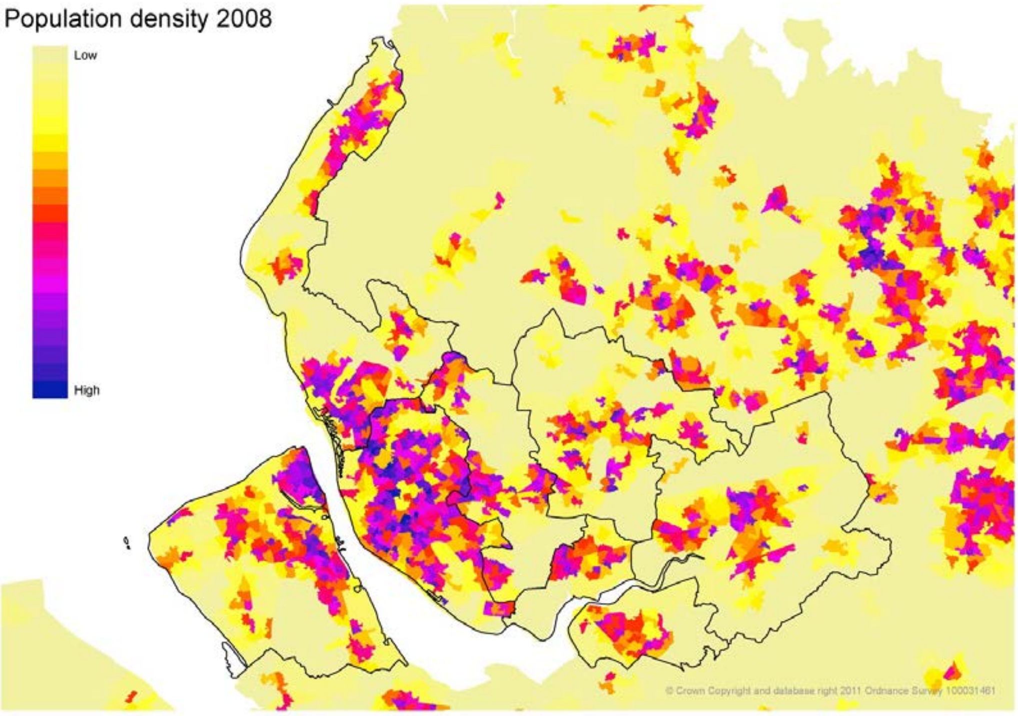
Table 6 Projected Population Change 2008 - 2024

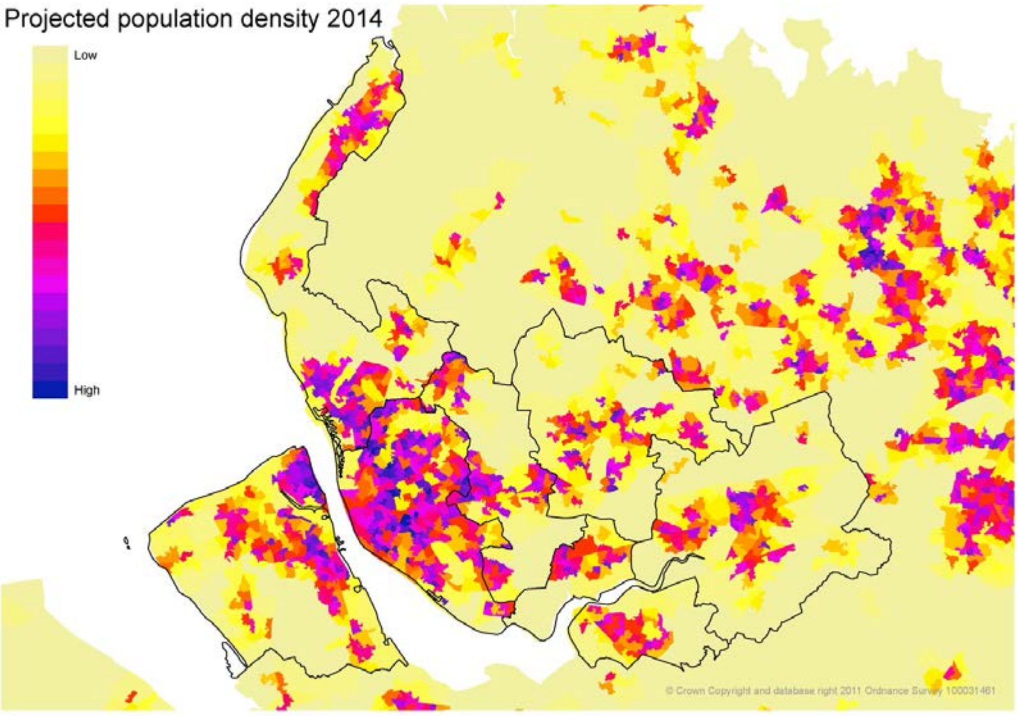
	Estimated population 2008	2011 census data (Nomis website[57])	Projected population 2014	Projected population 2024
Halton	119,762	125,800	124,997	129,586
Knowsley	150,841	145,900	153,564	157,214
Liverpool	434,864	466,400	452,093	467,264
Sefton	275,134	273,800	275,512	273,100
St.Helens	177,543	175,300	182,595	185,490
Warrington	196,206	202,200	196,091	190,060
Wirral	309,488	319,800	310,241	309,925
Total	1,663,838	1,709,200	1,695,093	1,712,639

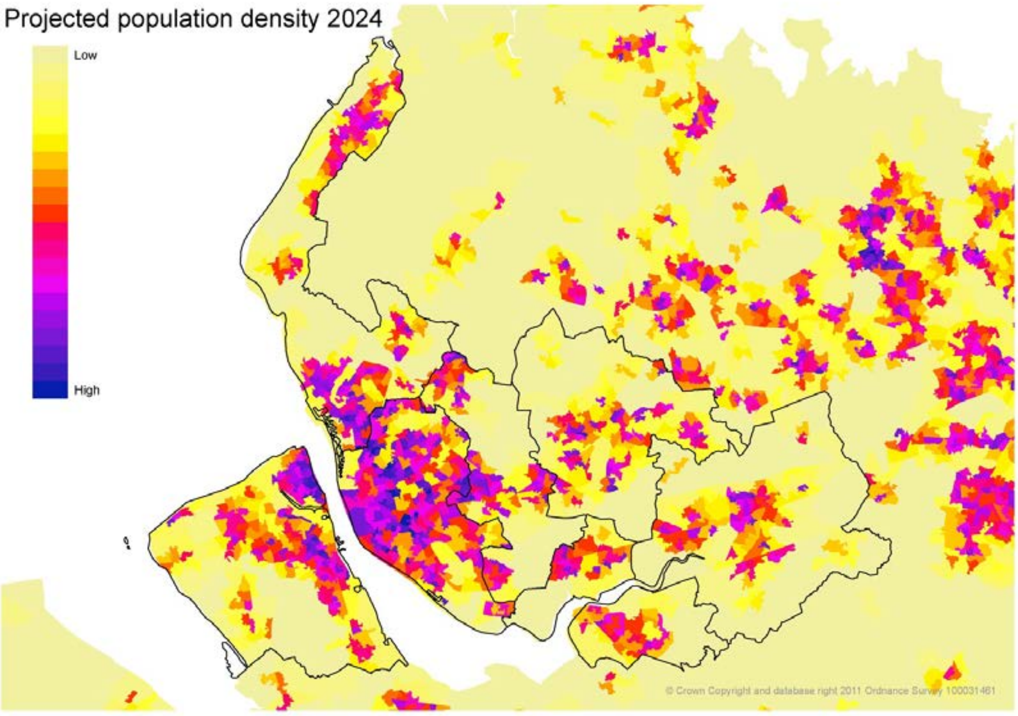
The census data indicates that overall population in the city region and Warrington has already exceeded the projection for 2014 and is 3000 below the 2024 projection.

Given other objectives such as that for Atlantic Gateway it could be envisaged that the population will significantly exceed the 2024 projection.

[57] http://www.nomisweb.co.uk/articles/658.aspx


Population density 2008
Low
High
© Crown Copyright and database right 2011 Ordnance Survey 100031461

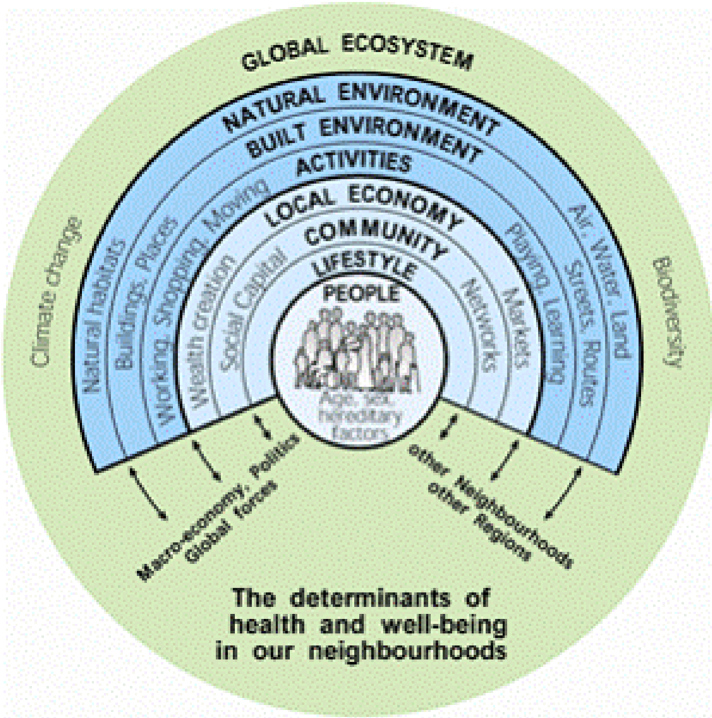

Projected population density 2014
Low
High
© Crown Copyright and database right 2011 Ordnance Survey 100031461


Projected population density 2024
Low
High
© Crown Copyright and database right 2011 Ordnance Survey 100031461

Health

Whitehead and Dahlgren described the wide range of determinants of health and wellbeing. The natural environment features as one element and it is therefore relevant to focus on how green infrastructure planning and delivery can help in promoting health and wellbeing across the city region and Liverpool.

Figure 15 Wider determinants of health[58]



The health sector in 2012 is undergoing considerable change. For this Framework we consider the health context as;

- The structural changes to the health profession
- The specific health issues in the city region which green infrastructure may be able to assist in reducing incidence and/or severity.
- The inequalities in health and wellbeing that exist across the city region

58 M Whitehead, G Dahlgren 1991, What can be done about inequalities in health? *The Lancet*, Volume 338, Issue 8774, Pages 1059-1063

Structural Change

The Public Health White Paper[59] outlines '*a radical shift in the way in which public health challenges are tackled'*. The strategy for public health in England responds to the Marmot Report and aims to

'*help people to live longer, healthier and more fulfilling lives; and to improve the health of the poorest fastest'*. '*Local government and local communities will be at the heart of improving health and wellbeing for their populations and tackling health inequalities'.*

Health and wellbeing throughout life is vital and part of this will be to ensure

'*active ageing is the norm rather than the exception'*.

'*Protecting green spaces and launching physical activity initiatives'* will be part of this. *'We will protect and promote community ownership of green spaces and improve access to land so that people can grow their own food'.*

There will be a new public health system with strong local and national leadership. Local health improvement functions, which include peoples' lifestyles, will be transferred to local government, with ring-fenced funding allocated to local government from April 2013.

'*Directors of Public Health will be the strategic leaders for public health and health inequalities in local communities, working in partnership with the local NHS and across the public, private and voluntary sectors'.*

The Directors of Public Health will be based within upper-tier and unitary local authorities. A National Health Service Commissioning Board will be set up and public health will be part of this Board's mandate, with public health support for NHS commissioning nationally and locally. There will be stronger incentives for GPs so that they play an active role in public health. Also it is proposed to create local statutory health and wellbeing boards to support collaboration across the NHS and local authorities in order to meet communities' needs as effectively as possible.

'The Department of Health has also proposed a new role for local government to encourage coherent commissioning strategies, promoting the development of integrated and joined up commissioning plans across the NHS, social care, public health and other local partners. Ultimately this should deliver better health and wellbeing outcomes, better quality of care and better value for money with fewer overlaps or gaps in provision and different services working sensibly together'.

There is clear recognition that the environment we live in impacts on our health and our life chances.

'*Improving the environment in which people live can make healthy lifestyles easier. When the immediate environment is unattractive, it is difficult to make physical activity and contact with nature part of everyday life. Unsafe and hostile urban areas that lack green spaces and are dominated by traffic can discourage activity. Lower socio economic groups and those living in the more deprived areas experience greatest environmental burdens'.*

59 HM Government (2010) Healthy Lives, Healthy People: Our strategy for public health in England. TSO, London. Available at: http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_121941

Overall there is greater emphasis on preventative measures in public health in line with comments received from public consultation.

Each local authority in the city region will have to develop a Public Health Strategy.

Health Issues

Green Infrastructure planning and delivery can be part of a holistic public health strategy to tackle physical and mental health issues. Specifically it can assist in several of the key health indicators that are monitored across the country.

In general the health of communities in the city region and Warrington is worse than the national average.

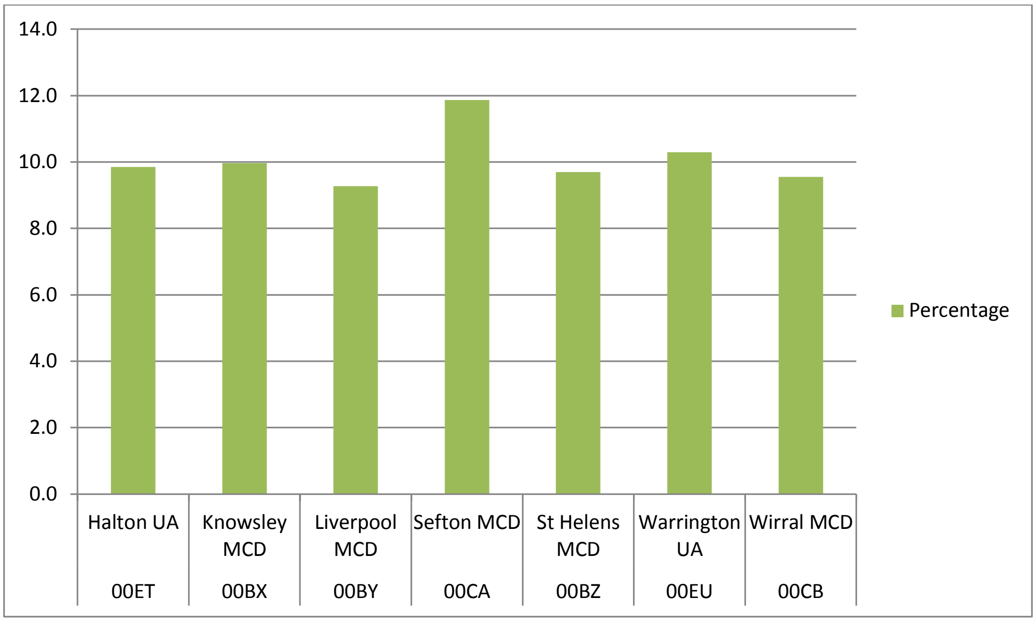
Local authority priorities for public health improvements are shown in Figure 16 Local authority public health priorities.
CHECK

Local authority	Mental Health	Obesity	Inequalities	Coronary Heart Disease
Halton	x	x		
Knowsley	x	x		x
Liverpool	x			
Sefton		x		x
St.Helens	x	x		
Warrington			X	x
Wirral			X	

Figure 16 Local authority public health priorities

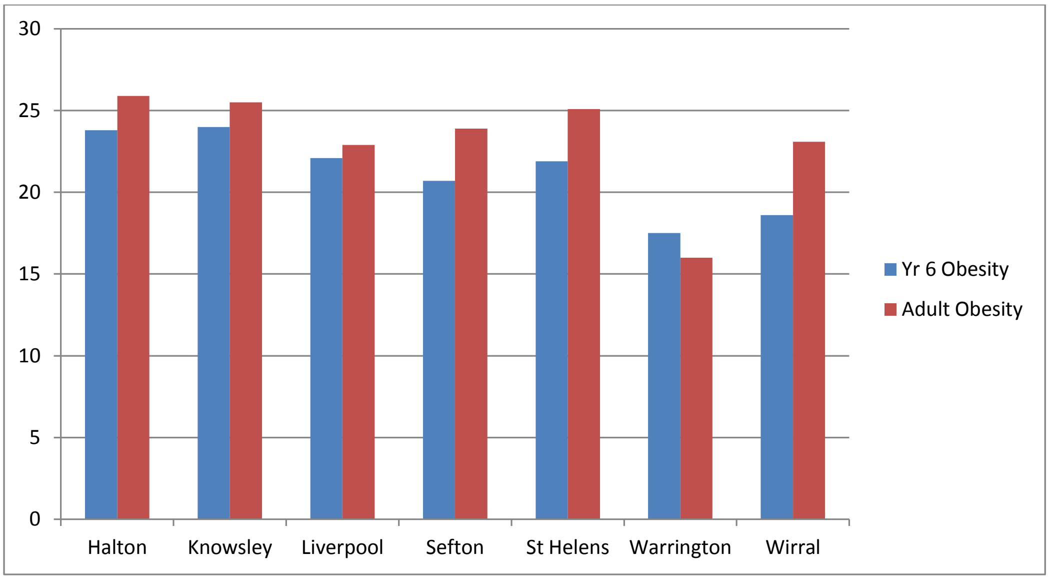
A relatively low percentage of adults are participating in the recommended levels of physical activity across the city region and Warrington. The proportion in Sefton is somewhat higher.

Figure 17 Percentage of adults participating in recommended levels of activity[60]



The levels for Year 6 childhood obesity and adult obesity are shown in Figure. Warrington shows significantly lower levels of obesity for both measures.

Figure 18 Percentage of Yr6 and Adult Obesity by Local Authority



60 Data derived from figures from the NW Public Health Observatory - http://www.nwph.net/nwpho/

The Cheshire and Merseyside Public Health Network Business Plan 2012/13 highlights the role of green infrastructure in improving population wellbeing across the city region and Warrington.

One specific action in the 2012/13 Business Plan is shown in Figure 19 Selected Objective from ChaMPs Business Plan 2012/13.

Figure 19 Selected Objective from ChaMPs Business Plan 2012/13

Objectives	Actions	Outcomes
Develop best practice in improving Population wellbeing and the determinants of wellbeing – e.g. parenting, green spaces	• To develop a business model and case for natural health service commissioning and joint strategic working via the Local Nature Partnerships	• To support strategic approaches to reducing inequalities in wellbeing • Improving the wider determinants of wellbeing through: b) Increased access to green space through developing shared commissioning models that increase usage by those most in need

Health inequalities

In February 2010, Sir Michael Marmot's 'Fair Society, Healthy Lives'[61] was published. This report, which has received cross party support, is critical to the Coalition Government's current thinking on the delivery of public health in England from 2011 and beyond. Health inequalities are costly to the whole of society and considerably reduce the life opportunities of many people in England. These health inequalities have widened in recent years despite efforts to the contrary and now a new approach is proposed that ensures that many sectors including the environment play their part to close the gap.

'Inequalities are a matter of life and death, of health and sickness, of well-being and misery. The fact that in England today people in different social circumstances experience avoidable differences in health, well-being and length of life is, quite simply, unfair. Creating a fairer society is fundamental to improving the health of the whole population and ensuring a fairer distribution of good health'.

'Inequalities in health arise because of inequalities in society – in the conditions in which people are born, grow, live, work and age. So close is the link between particular social and economic features of society and the distribution of health among the population, that the magnitude of health inequalities is a good marker of progress towards creating a fairer society. Taking action to reduce inequalities in health does not require a separate health agenda, but action across the whole of society'.

Data from the 2012 Health Profiles[62] for each local authority shows that life expectancy in the city region and Warrington is below the average for England in all authorities (Figure 20 Life Expectancy by local authority)

[61] Marmot, M.. (2010,) Fair Society, Healthy Lives. Strategic Review of Health Inequalities in England Post-2010 (The Marmot Review). Available at: http://www.instituteofhealthequity.org/
[62] Accessed from www.apho.org.uk/resource/view.aspx?RID=50215&REGION=50151&SPEAR

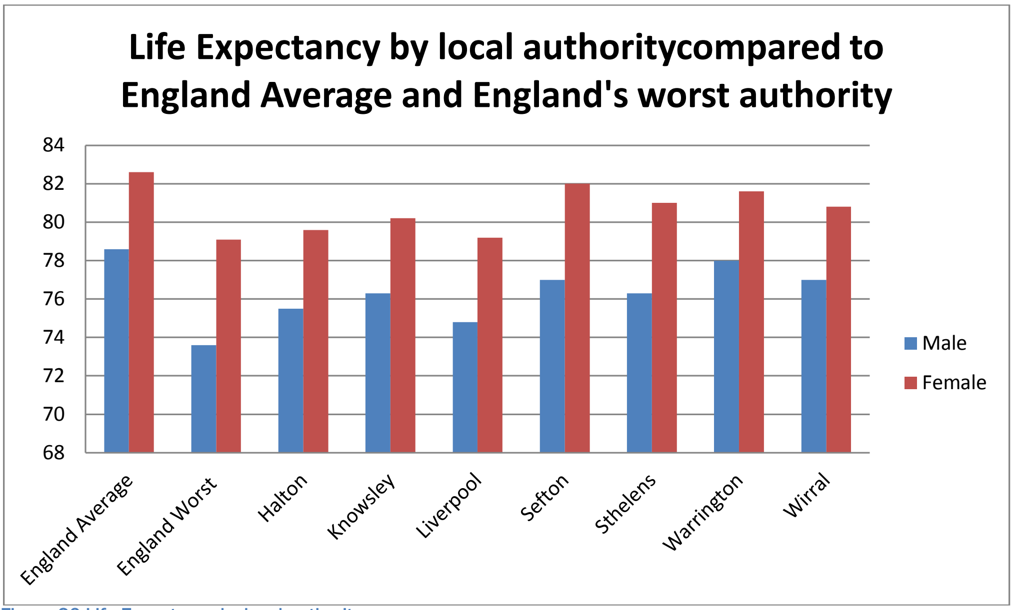
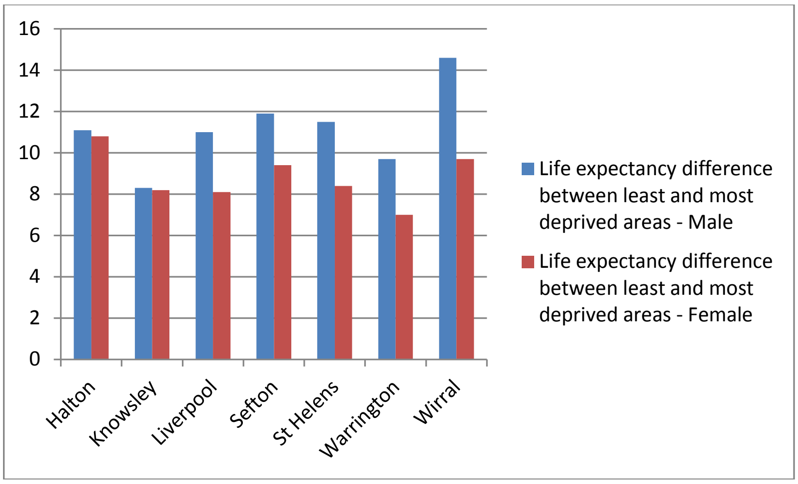


Figure 20 Life Expectancy by local authority

From the same data source we can also see that there is a great deal of difference in all authorities in life expectancy of those in the least and most deprived wards. In the case of men in Wirral it is over 14 years. This is one example health inequalities that exist within the Liverpool City Region and Warrington and also between this area and the rest if England.



The Marmot report identifies six policy objectives to help reduce health inequalities, one of which is to '*create and develop healthy and sustainable places and communities'.* A further policy recommendation suggests that improving the availability of good quality open and green spaces across the social gradient alongside improving active travel (for example walking and cycling) and the integration of the planning, transport; housing, environmental and health systems can help to reduce health inequalities.

Health inequalities stem from deprived social, economic and physical environments. The gains made in these areas in recent years through investments in infrastructure and innovative approaches need to be built on and extended rather than abandoned in the face of a more difficult financial climate.

Taking care of our environment can be cost-effective and life –enhancing for example, reducing car usage reduces pollution and pedestrian death.

Health is Wealth Commission

The Health is Wealth Commission[63] was set up by partners across Liverpool City Region order to look at the wider determinants of health across the Liverpool City Region. This highlighted the need for greater integration between land use planning and transport to reduce the need for travel and promote sustainable modes of transport. The Commission emphasised the need to place health at the heart of planning, and promoted the idea of greening the physical environment to provide health and wellbeing benefits, and in particular emphasised the role that the historic parks can play in our health and wellbeing. Several recommendations from the Commission have green infrastructure implications. The commission called for:

- *a co-ordinated 'Health Improvement Plan' for the City-region be developed, through which resources can be specifically focused on delivering and evaluating a unified and targeted strategy against the health impacts of alcohol, smoking, poor diet and lack of physical activity across the City-region*

- *'Design for Health and Wellbeing' initiative, led by the development of a Designing for Health and Wellbeing good practice guide.*

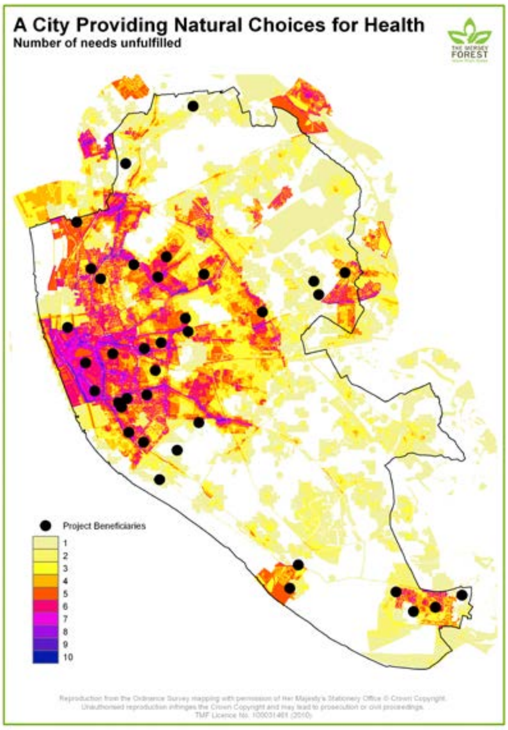
- *The establishment of a Parks Task Group, to investigate a new approach to the management, maintenance and marketing of urban parks.*

Liverpool City Green Infrastructure Strategy – Natural Choices

Liverpool PCT were joint commissioners of the Liverpool Green Infrastructure Strategy and this has been followed up with support for using green infrastructure to overcome health issues in the Public Health Strategy and further through the Natural Choices programme using the green infrastructure strategy to help target funding for projects to improve health and wellbeing.

Map 4 Successful targeting of green infrastructure projects in areas of greatest health need

[63] The Liverpool City-region Health is Wealth Commission (20092008) Health is Wealth. Final Report. Available at: http://www.liv.ac.uk/ihia/IMPACT%20Reports/HIW_Final_Report_sml.pdf



Decade of Health and Wellbeing

Following on from the success of the Year of Health and Wellbeing, Liverpool City Council has embarked on a Decade programme[64]. The Decade is supported by the city region through the Public Health Network, recognising the need to tackle issues across administrative boundaries.

The 5 Ways to Health and Wellbeing, originally developed by the New Economics Foundation is central to the delivery of the Decade programme. It identifies the actions that we all need to take and which ought to be enabled and supported across policy and strategy to assist in improving health and wellbeing.

Figure 21 5 ways to Health and Wellbeing

Five Ways to Wellbeing[65]

Connect...

64 http://www.2020healthandwellbeing.org.uk/index.php
65 New Economics Foundation & NHS Confederation (2011) Five Ways to Wellbeing. Available at: http://www.nhsconfed.org/Publications/Documents/Five_Ways_to_Wellbeing040711.pdf

With the people around you. With family, friends, colleagues and neighbours. At home, work, school or in your local community. Think of these as the cornerstones of your life and invest time in developing them. Building these connections will support and enrich you every day.

Be active…
Go for a walk or run. Step outside. Cycle. Play a game. Garden. Dance. Exercising makes you feel good. Most importantly, discover a physical activity you enjoy and that suits your level of mobility and fitness.

Take notice…
Be curious. Catch sight of the beautiful. Remark on the unusual. Notice the changing seasons. Savour the moment, whether you are walking to work, eating lunch or talking to friends. Be aware of the world around you and what you are feeling. Reflecting on your experiences will help you appreciate what matters to you.

Keep learning…
Try something new. Rediscover an old interest. Sign up for that course. Take on a different responsibility at work. Fix a bike. Learn to play an instrument or how to cook your favourite food. Set a challenge you will enjoy achieving. Learning new things will make you more confident as well as being fun.

Give…
Do something nice for a friend, or a stranger. Thank someone. Smile. Volunteer your time. Join a community group. Look out, as well as in. Seeing yourself, and your happiness, linked to the wider community can be incredibly rewarding and creates connections with the people around you.

Air Quality

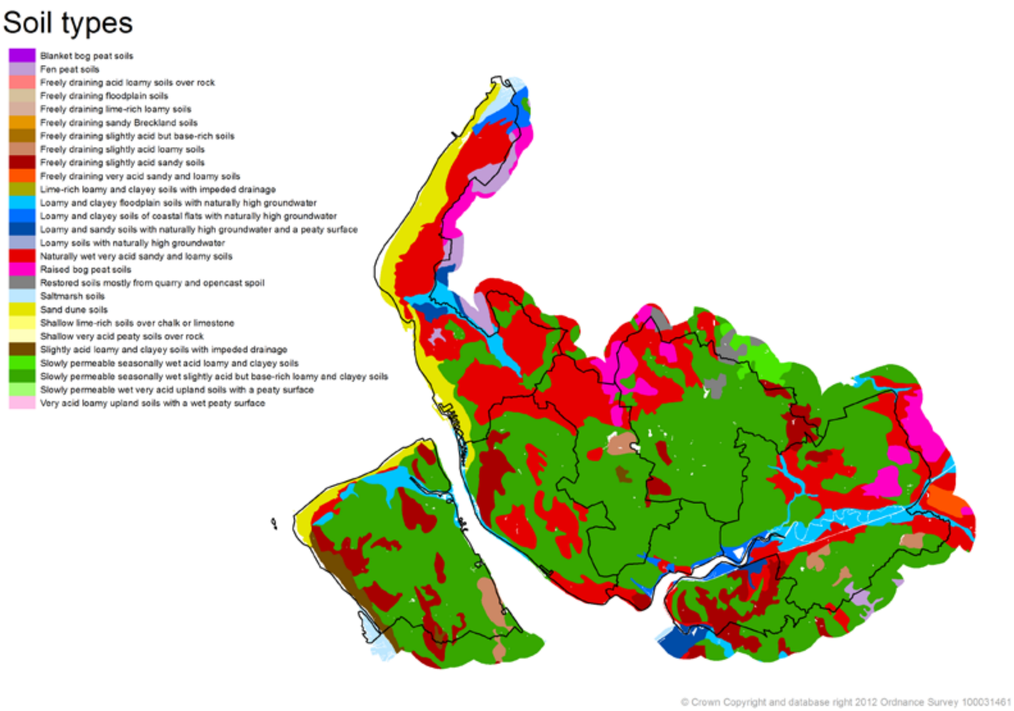
Several areas across the City Region and Warrington are not meeting the Air Quality Objectives of the National Air Quality Strategy

The major pollutants are Oxides of Nitrogen (NO_x), Carbon Monoxide (CO), Volatile Organic Compounds (VOCs) and particles less than 10 microns in diameter (PM10).

In parts of Liverpool the level of NO_x is so high that are not being met. In order to try and address this problem Liverpool City Council have declared two Air Quality Management Areas (AQMA's). The main source of NO_x is road transport and principally diesel engine vehicles.

Soil

Despite the publication in 2004 of a report on the state of soils in England and Wales there appears to be very little data available on the state of soils across the city region and Warrington. We do have data on soil types.



Green infrastructure relies on healthy soil to continue to grow and also on good management of soils to reduce the erosion that reduces water quality.

The lack of data makes it difficult to develop effective policies to protect and improve soil quality.

Projected Climate Change in the City Region and Warrington

Data from UK CIP 09 provides us with the best possible current indication of the impacts on scale of climate change projected for the city region. For the first time the data is presented with information of likelihood or probability that change will occur, allowing more detailed assessments of the scale of adaptation that may be needed.

In Northwest England, some headline changes by the 2080s are:

- 28% decrease in average summer precipitation – leading to reduced stream flows and water quality, increased drought, subsidence, changes to crops, serious water stress.
- 26% increase in average winter precipitation leading to increased flooding including from overwhelmed drains, subsidence, severe transport disruption, risks to critical infrastructure.
- 4.7ºC increase in average summer temperatures leading to increased heat stress, infrastructure risks, risks to biodiversity, heat related deaths, risks to food security.
- Across the UK, by 2095, relative sea levels could rise by 39-53cm.

Using natural, or green infrastructure interventions, is increasingly being recognised as a desirable 'win-win' approach to combating climate change[66].

In 2009 the City Region commissioned a "mini-Stern[67]" report to look at the impact on the area's economy of the current and planned regulation to tackle projected climate change. It identified that the city region had a per capita CO_2emission level below that of comparable urban areas, but that the economy still faces major challenges.

By 2020 the costs to businesses and public sector bodies of not adjusting and adapting could amount to 1% of the area's GVA. There are 90,000 jobs (15% of all current employment) in sectors that are likely to be significantly affected.

The study did not look at the impacts and costs more generally to society from projected climate change.

The Green Infrastructure to Combat Climate Change Framework,[68] part of the EU Interreg IVc GRaBs[69] project, has led the way in highlighting the issues, bringing partners together, developing support tools and identifying key actions for North West England that can help us to adapt our towns, cities and rural areas to climate change and help to mitigate climate change.

It sets out 27 actions that can be supported at a city region level, these range from developing city region exemplars (1e) through to cross boundary cooperation on Sustainable Urban Drainage Systems (13b).

The framework includes a number of resources such as an online evidence base, a mapping tool developed by Manchester University and resources for community groups to support discussion about what climate change may mean for them in their neighbourhood.

[66] Planning and Climate Change Coalition (2010) Planning for Climate Change – Guidance and model policies for local authorities. Available at: http://www.tcpa.org.uk/data/files/pccc_guidance_web.pdf
[67] http://www.investmerseyside.com/displaypage.asp?page_key=119 (accessed 27th May 2011) Regeneris Consulting and Quantum Strategy and Technology (2009) The Economic Impact of EU and UK Climate Change Legislation on Liverpool and the Liverpool City Region, Available at: http://www.merseyside.org.uk/dbimgs/MiniStern%20Final%20201109.pdf
[68] http://www.ginw.co.uk/climatechange Community Forests Northwest (2011) Green Infrastructure to combat climate change. A framework for action in Cheshire, Cumbria, Greater Manchester, Lancashire, and Merseyside. Available at: http://www.grabs-eu.org/downloads/NWDA_Framework_for_Action_March2011.pdf
[69] http://www.grabs-eu.org/

Figure 1 Green infrastructure to combat climate change tools

As part of this work STAR tools have been developed than enables assessment of maximum surface temperatures and surface water runoff given projected changes to climate, and also modelling changes to the green infrastructure in an area.

The Mersey Forest Partnership, as part of an Interreg IVb funded transnational cooperation, ForeStClim[70] is looking at how countries manage trees and woodlands so that they are both sustained and can deliver the benefits that we will need from them for climate change adaptation and as part of mitigation. As part of this cooperation the concept of "climate twinning" has emerged.

[70] www.forestclim.eu

Evolving Strategic Greenspace Issues in Local Authorities

The Green Infrastructure Framework must both assist in informing the statutory development plans of the Merseyside authorities and Warrington and at the same time be aware of, and consistent with, their evolving policies particularly as they relate spatially to green infrastructure. The following is a checklist of specific references to significant green infrastructure referred to in the Core Strategies in autumn 2012:

Liverpool

- Green wedges at Otterspool and Calderstones/Woolton which comprise extensive areas of linked open spaces
- City Parks including Garden Festival site
- Mersey Waterfront Regional park

St.Helens

- Bold Forest Park
- Stanley Bank, Carr Mill dam and Billinge Hill Corridor
- Former Lyme and Wood Pits
- Sankey Valley Park between St Helens and Warrington
- Former Brickfields Quarry

Wirral

- Dee estuary

Sefton

- Sefton Coast
- Leeds-Liverpool canal Corridor

Knowsley

- Alt Corridor
- Valley Corridor
- Whiston to Cronton Corridor
- Trans Pennine Trail
- M57 Green Belt Corridor
- Knowsley Hall Estate

Halton

- Widnes Waterfront
- Sankey canal
- Green Lungs
- Trans Pennine Trail

Warrington

- A49 corridor
- Sankey Valley Park
- Mersey Valley Corridor
- Trans Pennine Trail
- Walton Hall Gardens
- Victoria Park
- Orford Park

National policy context

Since coming to power in May 2010 the Coalition Government has commenced on a comprehensive review of policy within the overriding context of fiscal prudence. These policies are still evolving and include the following a national planning policy statement is not envisaged before summer 2012

However there are a number of decisions which will have a major influence on green infrastructure planning for the city region:

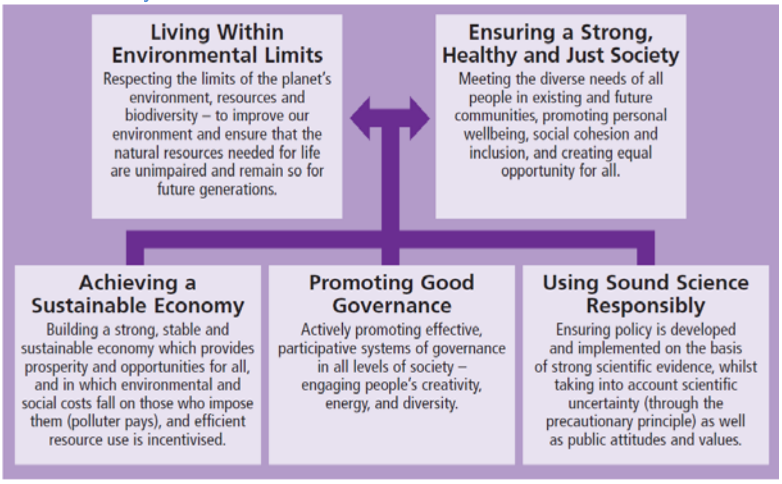
- A commitment to sustainable development
- The need to tackle climate change
- The removal of the regional tier of governance
- Introduction of Local Economic Partnerships
- Priority to be given to decision making at the local level through neighbourhood plans
- A requirement for local authorities to cooperate across boundaries
- Community led engagement
- A period of severe public sector financial constraint

Sustainable Development

The UK Government's Strategy for Sustainable Development was launched in 2005 setting out the guiding principles of sustainable development; social cohesion and inclusion; enhancement of the environment; prudent use of natural resources and sustainable economic development. The role of the planning system was elaborated in PPS1-Delivering Sustainable Development.

In February 2011, the Coalition Government produced its response to the Environment Audit Committee report. In this document[71] the Coalition affirmed its support for the 2005 Strategy for Sustainable Development and also the Sustainability Framework.

Figure 22 Sustainability framework[72]



[71] DEFRA (2011) Mainstreaming sustainable development – The Government's vision and what this means in practice, DEFRA, 2011 - http://www.sd-commission.org.uk/presslist.php/119/what-next-for-sustainable-development. DEFRA, London. Available at: http://sd.defra.gov.uk/documents/mainstreaming-sustainable-development.pdf

[72] DEFRA (2005) Securing the future - delivering UK sustainable development strategy. DEFRA, London. Available at: http://www.defra.gov.uk/publications/files/pb10589-securing-the-future-050307.pdf

In addition the Government identified "Natural Capital", as being an essential part of a productive economy and the need to value this capital appropriately, a Green Bank to support the move to a green economy and increased use of environmental taxes.

The document also identified the National Ecosystems report and the Natural Environment White Paper as important in helping to measure and value natural capital.

Natural Economy White Paper

The White Paper was published in June 2011 and sets out the Government's proposals to protect and enhance the natural environment. Key measures include:

- Creation of Nature Improvement Areas to provide bigger, more connected places for nature to live in and adapt to climate change with a fund of £7.5 million to support the first 12 areas
- New Local Nature Partnerships to strengthen joined up thinking across agencies and organisations including links with the Local Enterprise Partnerships.

Such partnerships may cross administrative boundaries, so that they can reflect natural features, systems and landscapes, and work at a scale that has most impact. Where necessary, they may join up on cross-boundary issues, such as landscape scale action for biodiversity, water management, green infrastructure, air quality and ecosystem services more widely.[73]

- Allowing local communities to give protection to areas that are important to them for recreation, the view or their importance for wildlife
- Strengthening local public health activities which connect people with nature for better health.

The White Paper acts on the recommendations of “Making Space for Nature”, the report into the state of England’s wildlife sites led by Professor John Lawton[74]. The report showed that England’s wildlife sites are fragmented and not able to respond to the pressures of climate change and other pressures placed on the land.

Green infrastructure is identified as a key issue throughout the document. One action is the proposed development of a Green Infrastructure Partnership at national level.

Ecosystem Services

In June 2011 the National Ecosystems Assessment which demonstrated the strong economic arguments for safeguarding and enhancing[75] was published. This for the first time looked at the health and value of the natural environment across the whole of the UK.

Six scenarios described a range of possible futures for our natural environment and the value that it provides.

[73] HM Government (2011) The Natural Choice, Securing: securing the value of nature. Available at: http://www.official-documents.gov.uk/document/cm80/8082/8082.pdf
[74] http://archive.defra.gov.uk/environment/biodiversity/documents/201009space-for-nature.pdf
[75] UK National Ecosystem Assessment (2011) The UK National Ecosystem Assessment: Synthesis of the Key Findings. UNEP-WCMC, Cambridge. Available at: http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx

Figure 23 Taken from UK National Ecosystems Assessment Synthesis Report

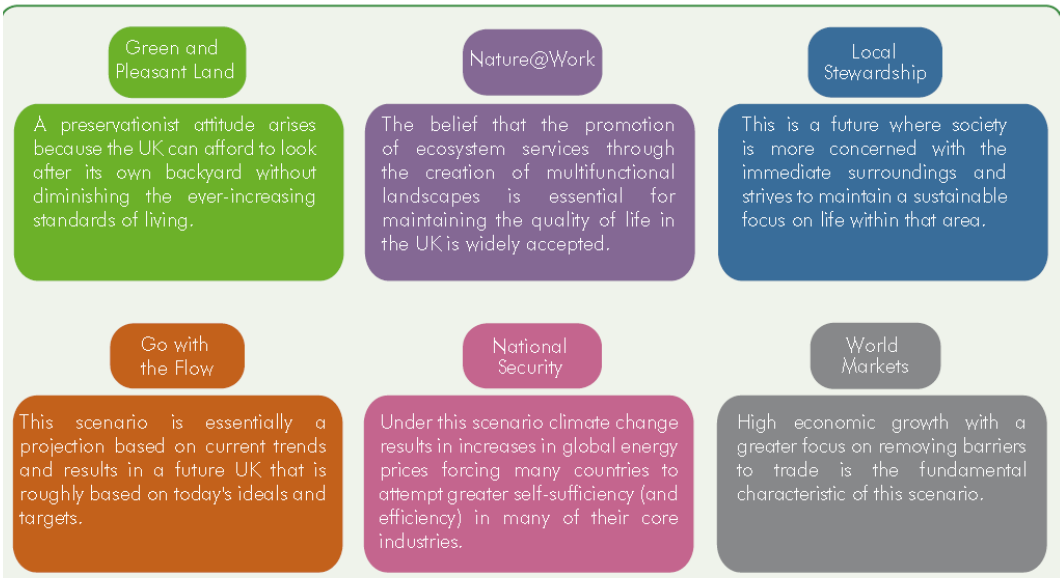


Figure 8 An overview of the six scenarios developed for the UK NEA. All share the common characteristics of a decline in global resource availability and an ageing UK population. They also include some level of technological innovation, although there are differences in the sectors involved.

The main findings of the assessment are:

- The natural world, its biodiversity and its constituent ecosystems are critically important to our well-being and economic prosperity, but are consistently undervalued in conventional economic analyses and decision making.
- Ecosystems and ecosystem services, and the ways people benefit from them, have changed markedly in the past 60 years, driven by changes in society.
- The UK's ecosystems are currently delivering some services well, but others are still in long-term decline.
- The UK population will continue to grow, and its demands and expectations continue to evolve. This is likely to increase pressures on ecosystem services in a future where climate change will have an accelerating impact both here and in the world at large.
- Actions taken and decisions made now will have consequences far into the future for ecosystems, ecosystem services and human well-being. It is important that these are understood, so that we can make the best possible choices, not just for society now but also for future generations.
- A move to sustainable development will require an appropriate mixture of regulations, technology, financial investment and education, as well as changes in individual and societal behaviour and adoption of a more integrated, rather than conventional sectoral, approach to ecosystem management[76]
- The assessment also suggests that society derives over £30bn/annum in health and welfare benefits alone from the natural environment.

[76] http://www.defra.gov.uk/environment/natural/uknea/ (accessed 12 June 2011)

At a global level The Millennium Ecosystems Assessment[77] (MA) assessed the consequences of ecosystem change for human wellbeing and the scientific basis for action needed to enhance the conservation and sustainable use of those who understand systems and their economies best should lead their contribution to human well-being. The following paragraphs are taken from the MA website.

- Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, fresh water, timber, fibre and fuel. This has resulted in a substantial and largely irreversible loss in the diversity of life on Earth.

- The changes that have been made to ecosystems have contributed to substantial net gains in human well-being and economic development and enable all places to fulfil their potential, but these gains have been achieved at growing costs in the form of the degradation of many ecosystem services, increased risks of nonlinear changes, and the exacerbation of poverty for some groups of people. These problems, unless addressed, will substantially diminish the benefits that future generations obtain from ecosystems.

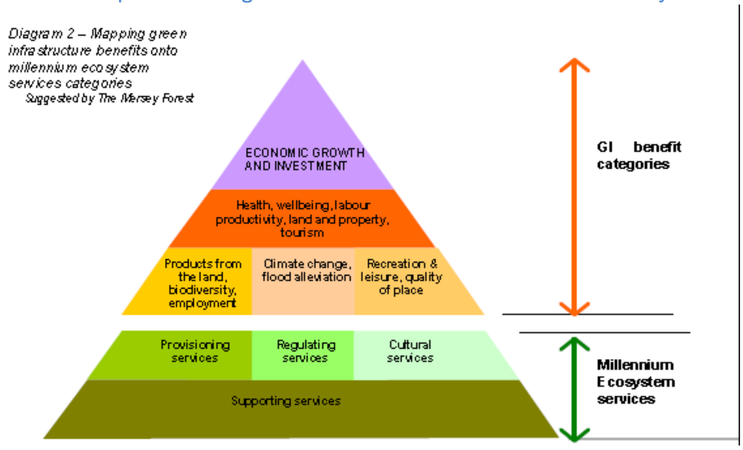
- Increasing confidence to invest - create the right conditions for growth through Government allowing market forces to determine where growth takes place and provide incentives which ensure that local communities benefit from development.

- Focused intervention – tackling barriers to growth that the market will not address itself, supporting investment that will have a long term impact on growth and supporting areas with long term growth challenges manage their transition to what is appropriate for the local area. Government policies should work with the market, not seek to artificially create growth.

Green infrastructure planning is an ecosystem services based approach. It looks to identify, highlight and promote how and where the natural environment underpins our society and economy and identify how we can manage this infrastructure in a sustainable manner to support human wellbeing.

[77] http://www.maweb.org/en/About.aspx#1

Figure 24 Relationship between the green infrastructure benefits and Millennium Ecosystem Services model



Localism Act 2011

The Localism Bill was introduced to Parliament in December 2010 with the underlying aim of shifting power from central government to individuals, communities and councils. Provisions in the Bill include:

- The abolition of the regional spatial strategies
- A duty to cooperate that requires local authorities and other public bodies to work together on planning matters.
- A requirement for communities to draw up neighbourhood development plans consistent with the Councils local plan and national guidance
- The ability to use community infrastructure levy funds on maintaining infrastructure, creating new infrastructure

National Planning Policy Framework

The National Planning Policy Framework[78] was published in March 2012 and is designed to consolidate and simplify guidance for the preparation of development plans and assessment of planning applications.

In relation to green infrastructure the document encourages local authorities to: "set out a strategic approach in their local plans, planning positively for the:

"creation, protection, enhancement and management of networks of biodiversity and green infrastructure"

An accompanying appendix encourages a more strategic approach to green infrastructure and a better understanding of the existing green infrastructure network and its functions in their area.

Approved Community Forest Plans such as The Mersey Forest Plan are highlighted as material considerations.

[78] https://www.gov.uk/government/publications/national-planning-policy-framework--2

Health

Much of the national agenda for Health has been covered in the section on health in the city region.

Natural Environment White Paper – The Natural Choice: Securing the Value of Nature

The White Paper aims to halt biodiversity loss by 2020 by supporting healthy functioning ecosystems and establishing coherent ecological networks. It is informed by the NEA (above) and the Lawton Report - Making Space for Nature[79].

The Lawton Report sets out the case for improving our ecological network. It highlights the ethical case for biodiversity conservation and also clearly sets out the value of the natural environment in providing services and benefits critical to the wellbeing of individuals, communities and the economy.

Urban green infrastructure is cited as being an effective tool for managing environmental risks such as flooding and heat waves and advocates green spaces being factored into all development.

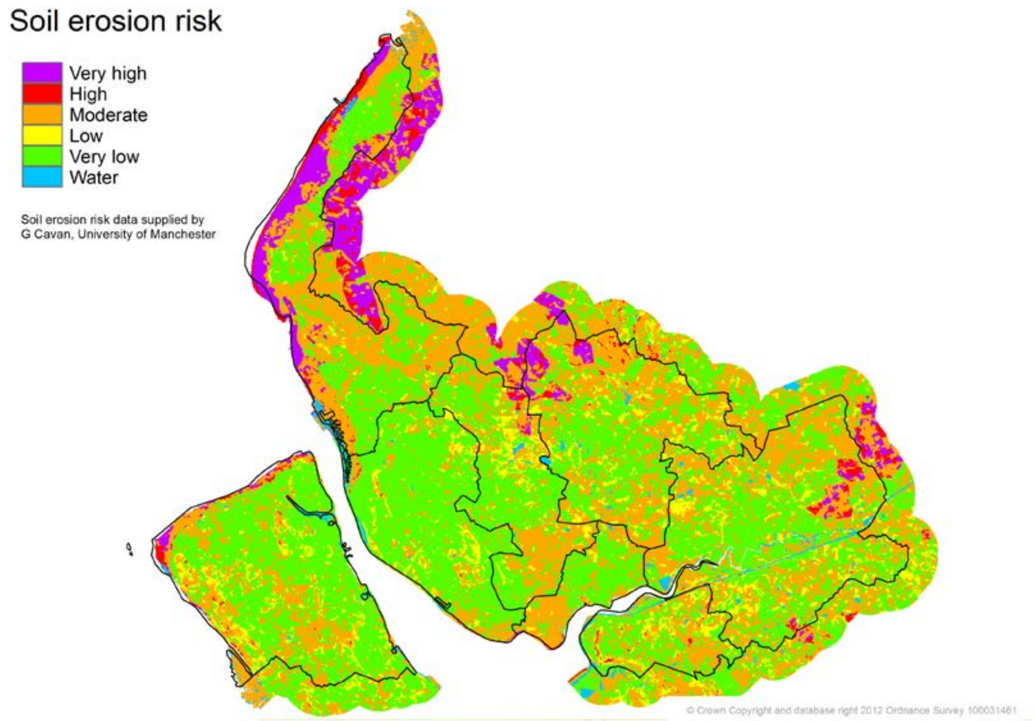
The White Paper also introduced

- Local Nature Partnerships – Working closely with LEP and the Health and Wellbeing Boards to contribute to local plan making
- Biodiversity Offsets – Conservation activities designed to deliver biodiversity benefits to compensate biodiversity loss from development
- Green Infrastructure Partnership

In addition the White paper outlined a vision for England' soil resource. This set a clear target for sustainable soil management by 2030 we want all of England's soils to be managed sustainably. One key driver is to safeguard the ability to provide essential ecosystem services and functions.

Action to tackle soil degradation threats in agricultural soils through the Soil Protection Review 2010 (SPR) is underway through options in Environmental Stewardship and cross compliance.

[79] Lawton, J. (2010) Making Space for Nature: A review of England's Wildlife Sites and Ecological Network. Available at: http://archive.defra.gov.uk/environment/biodiversity/documents/201009space-for-nature.pdf



Biodiversity Strategy for England – Biodiversity 2020: A Strategy for England's Wildlife and Ecosystem Services

This sets out how international and EU commitments on biodiversity are to be implemented. It highlights the importance of the planning system in guiding development to the best locations, encouraging greener design and enhancing natural networks.

The UK is a signatory to the Convention on Biological Diversity (CBD) and is committed to the new biodiversity goals and targets 'the Aichi Targets' agreed in 2010 and set out in the Strategic Plan for Biodiversity 2011–2020[80]. The UK is also committed to developing and using a set of indicators to report on progress towards meeting these international goals and targets.

Climate change

National policy around climate change has developed rapidly over the last 12 years. Whilst the focus is mainly on energy issues and the development of a low carbon economy, aspects of most of the legislation and policy have potential green infrastructure impacts.

80 http://www.cbd.int/doc/strategic-plan/2011-2020/Aichi-Targets-EN.pdf CBD and UNEP (2010) Strategic Plan for Biodiversity 2011-2020 and the Aichi Targets. Available at: http://www.cbd.int/doc/strategic-plan/2011-2020/Aichi-Targets-EN.pdf

The overview below is taken from a Policy Paper published in August 2011 by the Centre for Climate Change Economics and Policy and Grantham Research Institute on Climate Change and the Environment[81].

2000: Climate Change Programme. This report set out policies and priorities for action both in the United Kingdom and internationally. Updated in 2006, the policies are supposed to reduce CO2emissions by 15-18% below 1990 levels by 2010 and overall GHG emissions by 23-25%.

2001: The Climate Change Levy (CCL) was introduced on 1 April 2001, effectively replacing the Fossil Fuel Levy. It is a downstream tax on non-domestic energy use by industry and the public sector, designed to incentivise energy efficiency and emission reductions, with part of the revenue being used to reduce National Insurance contributions. Energy-intensive firms can receive up to an 80% discount if they join a Climate Change Agreement (CCA), which requires meeting energy efficiency or carbon-saving targets. Renewable electricity suppliers are exempt from the CCL. Receipts from the CCL amounted to £0.7 billion in 2009.

2002: The Renewables Obligation (RO) replaced the NFFO and SRO as the primary renewable energy policy instrument. The RO requires electricity end-suppliers to purchase a certain fraction of their annual electricity supply from producers using specific renewable technologies, and they receive tradable Renewables Obligation Certificates (ROCs) for doing so. The supplier can also 'buy out' the obligation by paying a set price per MWh. The buy-out revenue is recycled to participating suppliers in proportion to their ROCs.

2005: European Union Emissions Trading System (EU ETS). The UK Emissions Trading Scheme closed in 2006 and was replaced by the EU's that aims at ensuring compliance with the Kyoto obligations. Under the EU system, member states proposed National Allocation Plans (NAPs) to the European Commission, allocating a set proportion of a country's total 2008-2012 emission budget to sectors covered by the scheme; tradable quotas were then divided among firms (www.eea.europa.eu/pressroom/newsreleases/questions-and-answers-on-key).

2008: Climate Change Act. This Act set a legally binding target of 80% reductions in emissions from 1990 to 2050. A medium-term target of a 34% reduction by 2020 was also adopted, with the promise of a further tightening in the event of a global deal on climate change. To achieve these targets, the Act established the principle of five-year carbon budgets. The first three budgets were set in 2009 and cover 2008-12, 2013-17 and 2018-22. The fourth budget, 2023-2027, which was recently proposed by the UK Committee on Climate Change, is currently under consideration by the Government, and will be legislated in June 2011 (as this working paper was being finalised, the Government accepted the proposed fourth carbon budget. Contributions from the use of carbon trading and offsets will be allowed. There will be a review in 2014 to ensure that the UK efforts are not disproportionate relative to those of other EU members). The Government must submit its policies to meet these budgets to Parliament, as it did in the Low-Carbon Transition Plan of
July 2009, which set out policies to cut emissions across the power and heavy industry sector; the transport sector; in homes and communities, workplaces and jobs; in agriculture; and in land use and waste management. The Act also requires the government to include aviation and shipping emissions, or provide an explanation why not, by the end of 2012.

2010: Carbon Reduction Commitment Energy Efficiency Scheme (CRC EES). Established under the Climate Change Act 2008, the scheme covers emissions by firms and public bodies not already subject to the EU system or substantially covered by other agreements. It comprises reporting requirements and a carbon levy. The CRC EES is complemented by several other policies to promote energy efficiency in residential buildings.

2011: Carbon Plan. Released in draft form in March, the Carbon Plan is a government-wide carbon reduction plan, including domestic and international emissions. It sets out a vision, plan and timetable for achieving the United Kingdom's 2020 emission reduction targets, department by department. Updates on progress will be released quarterly and a final plan will be released following the confirmation of the fourth carbon budget in June 2011.

[81] Bowen, A. And Rydge, J. (2011) Climate change policy in the United Kingdom. Centre for Climate Change Economics and Policy Grantham Research Institute on Climate Change and the Environment. Available at: http://www.cccep.ac.uk/Publications/Policy/docs/PP_climate-change-policy-uk.pdf.

2012: Green Investment Bank (GIB). A GIB to unlock finance for the transition to low-carbon growth will commence operations during the latter half of 2012. The Spring 2011 Budget committed £3 billion in funding, with borrowing powers available from 2015-16 (conditional on government deficit reduction targets being met).
2012: Renewable Heat Incentive (RHI) will provide long-term financial support across a wide range of renewable heat installations installed after 15 July 2009, and will commence in mid-2011 in two phases. It will initially provide long-term tariff support in non-domestic sectors. Limited support for households, capped at £15 million, will be available through Renewable Heat Premium Payments. In the second phase, which will commence in late 2012 to coincide with the introduction of the 'Green Deal', households will become eligible for long-term tariff support.
2012: The Energy Bill. Currently awaiting Report Stage in Parliament, this bill includes provisions for a 'Green Deal' on energy efficiency, greater security of energy supplies and more low-carbon electricity. More detailed secondary legislation for the 'Green Deal' will be prepared during 2011 with a formal consultation process recently completed. Secondary legislation will be laid before parliament in early 2012 with the first 'Green Deal' expected to be available in late 2012. This policy will be accompanied by funding for training for up to 1,000 'Green Deal' apprenticeships.

In addition as part of the Forestry Commission response to the Read Review[82] the Woodland Carbon Code has been developed.

The Code sets out design and management requirements for voluntary UK based projects that aim to sequester carbon through woodland creation.

It does account for

- carbon sequestration and emissions for new woodland creation, within the woodland boundary
- woodland created by planting and natural regeneration (where some intervention is necessary to establish woodland)
- carbon sequestration and emissions under various management regimes from frequent clear felling to minimum intervention woodland.
- emissions outside the woodland boundary as a result of the project going ahead

It does not account for

- additional carbon sequestration due to changes to the management of existing woodland
- carbon stored in forest products
- the carbon saved when substituting wood products or fuels for other products or fuels with a larger carbon footprint.[83]

[82] http://www.forestry.gov.uk/forestry/infd-7y4gn9 Read, D.J., Freer-Smith, P.H., Morison, J.I.L., Hanley, N., West, C.C. and Snowdon, P. (eds.)(2009) Combating climate change – a role for UK forests. An assessment of the potential of the UK's trees and woodlands to mitigate and adapt to climate change. The Stationery Office, Edinburgh. Available at: http://www.tsoshop.co.uk/gempdf/Climate_Change_Main_Report.pdf

[83] http://www.forestry.gov.uk/forestry/INFD-8JRM37 Forestry Commission (2012) Scope of the Woodland Carbon Code. Available at: http://www.forestry.gov.uk/forestry/INFD-8JRM37

11. Liverpool City Region Green Infrastructure Framework

Step 1 Partnership and Priorities

Partnerships

One purpose of the Liverpool City Region Green Infrastructure framework is to bring people together to develop shared priorities and agree actions that can be delivered through cooperation between sectors and organisations.

During the development of this framework there has been input from a wide range of stakeholders both at the workshops and seminars that have been organised, through presentations to individual groups and through discussion with a wide range of organisations that have or may have an interest in aspects of green infrastructure planning.

Partners have provided data and other information as well as comments on the developing framework.

Developing Priorities

Six priorities have been identified from discussions with stakeholders. The rationale for each the inclusion of each of the six is shown in Table 7.

There is now an extensive evidence base to support the assertion that green infrastructure can play an important role in supporting each of these priorities[84]. A sample of the evidence is shown for each priority in Appendix 3.

Table 7 Rationale for selection of Framework Priorities

Priority	Rationale
Setting the Scene for Growth	Green infrastructure can be the setting for the economy, creating good quality of place and providing an excellent quality of life, supporting sustainable economic growth.
Supporting Health and Wellbeing	Green infrastructure provides a wealth of health benefits. The city region has areas of extreme poor health that require long term and innovative solutions. The basis for activity under this priority is both to promote better health and to provide for recovery or healing from illness.
Providing Recreation, Leisure and Tourism	High quality green infrastructure attracts visitors and can increase the length of stay as well as attracting new visitors. High quality access and recreation provides the playground for those who live, work and visit the city region.
Developing the Rural Economy	The rural economy relies on green infrastructure for many of its attributes. Urban areas receive many green infrastructure benefits from rural areas, but the link between urban and rural and their interdependencies are not always recognised.
Supporting Adaptation to Climate Change	Green infrastructure provides an evidence base set of adaptation and mitigation actions that can prepare the region for projected climate change and assist in the development of a low carbon economy.
Enhancing the Ecological Framework	Biodiversity is a barometer for the health of the environment or our green infrastructure; it is the basis for all of the functions that we depend upon. Creating networks and improving connectivity helps to conserve our natural heritage and improves the resilience of our green

[84] For example the database developed by Forestry Commission as part of their information to DEFRA and CLG provides a wide range of information on all of these priorities (The Liverpool Green Infrastructure Strategy database also provides of comprehensive information, with many more local examples.).

	infrastructure, enabling improved functionality.

In this framework we are looking at areas that are potentially important at a city region level. This does not undermine areas or issues that are important locally, but seeks to highlight what should be supported, for mutual benefit, at the city region level, where cooperation across administrative boundaries is essential.

In order to help to confirm that these six priorities are appropriately planned for in green infrastructure terms at the sub regional scale the following questions were answered and agreed by partners.

- Could green infrastructure planning at this level support planning at a lower level?
- Could this green infrastructure planning be done at a higher level?
- Is there policy/strategy support for sub regional working on this issue?
- Does the issue cross administrative boundaries?
- Will it provide information that would not otherwise be available at the levels above and below?

Table 8 provides a summary of the responses to these questions, which have been discussed with partners. The table shows that overall a city region approach can be justified. The loss of regional layers of policy and strategy in fact strengthen the need for the work to be undertaken in order to tackle cross boundary issues.

Table 8

	Priority					
Question	Setting the Scene for Growth	Climate Change	Recreation, leisure and tourism	Ecological framework	Rural Economy	Health and Well being
Will this provide evidence for green infrastructure planning at a local authority level?	Yes - on key routes and for city region strategic sites	Yes - to support local climate change and flood management plans.	Yes – on key strategic routes.	Yes – on key elements of an ecological framework.	Yes - on range of sectors comprising the rural economy, and are dispersed across the sub region.	Yes – on key strategic issues
Could this work be done at a higher administrative level?	Possibly at Atlantic Gateway scale.	Possibly - but information will be more generic and not linked to specific areas of green infrastructure.	No	No	No - Merseyside has a specific "signature" for its rural economy and needs a specific sub regional plan.	No
Policy/Strategic support for work at this level?	Yes –Local Enterprise Partnership, Local Nature Partnership, National Planning Policy Framework	Yes through the Local Nature Partnership and Local Enterprise Partnership	CHAMPs Business Plan	North Merseyside BAP. And Ecological Framework	Rural Economy Action Plan	CHAMPs Business Plan
Is this a cross boundary issue?	Yes	Yes	Yes	Yes	Yes	Yes
Is there linkage with the city region structures	Yes - Economy; Employment and Skills: Planning and Housing; Safer, Healthier Communities, LEP	Yes - Planning and Housing; Safer, Healthier Communities, LEP and LNP, CHAMPs	Yes - Economy; Employment & Skills; Planning & Housing; Safer, Healthier Communities, LEP	Yes - Planning and Housing; LEP and LNP	Yes - Economy; Employment and Skills: Planning and Housing; LEP and LNP	Healthier Communities, LEP and LNP, CHAMPs

	and LNP		and LNP			
Will it provide information that would not otherwise be available at the levels above and below?	Yes - more detail than level above, cross boundary issues for levels below	Yes - detail on the green infrastructure that can provide green infrastructure functionality outside of the individual local authority areas.	Yes	Yes	Yes	Yes

Issues and key questions for each of the priorities -

Overview

Issues arising from the policies and strategies discussed briefly in Section 10 above have been identified for each of the six agreed priorities for the Liverpool City Region Green Infrastructure Framework.

A series of questions related to how green infrastructure can help address these issues are posed.

For example in response to the issue raised by the City Region Deal (Link)

"... How the River Mersey can become the cleanest river in an urban setting by 2045, with the commensurate economic benefits.[85]"

The question is

"How can green infrastructure planning and delivery assist in improving the water quality of the River Mersey and its tributaries?"

These questions are the basis for identifying key aspects of green infrastructure planning and management at the city region level.

The answers to the questions often have two parts.

- Where in the city region can or does green infrastructure have a role to play?
- What are the types of planning/action that are appropriate?

Providing this information requires additional analysis of the GIS data that has been gathered and also the compilation of evidence to support the assertion that the identified actions can address the question being asked.

For example and using the same question related to the Mersey data from the GI assessment can be combined with EA data on areas that fail the Water Framework Directive for a range of water quality measures to assess places where GI may be able to managed or created to improve water quality.

The evidence to support specific actions is summarised and links provided to other GI Evidence databases.

[85] http://liverpool.gov.uk/news/details.aspx?id=216961 Liverpool City Council (2012) City region deal with government. Available at: http://liverpool.gov.uk/news/details.aspx?id=216961

Setting the Scene for Growth

Issues

National and local focus is to create new jobs and businesses in the private sector, rebalance the economy toward manufacturing and increase productivity. The focus is on media and knowledge based jobs, green jobs related to low carbon economy and the potential for jobs associated with new port and infrastructure projects such as Liverpool and Wirral Waters and the second Mersey Crossing. Liverpool and Wirral Waters have been identified as Enterprise Zones[86].

The programme set out in Atlantic Gateway suggests 150,000 new jobs will be created over the next 30 years. Wirral Waters anticipate investment of £5bn in the new international trade centre.

Tourism is seen as a key driver for the city region economy and many of the main tourism brands are themselves green infrastructure (e.g. golf courses).

Emerging regeneration frameworks are identifying where private sector investment needs to be supported and linked to programmes that can maximise economic and sustainable development benefits. One example is the SRF for North Liverpool and South Sefton[87].

Atlantic Gateway provides a high level cross boundary strategy for the sustainable development of the city region and Warrington, with a focus on:

- Delivering new, sustainable infrastructure to support the growth of the city region
- Creating high quality environments to attract and retain people and provide a high quality of place and life.

Establishing the River Mersey as the cleanest urban river in Europe can help deliver significant economic benefits.

Key Questions

- What and where are the green infrastructure assets that support economic investment in the sub region?
- What and where are the "pinch points" constraining economic investment in the sub region and Warrington and what are the potential green infrastructure solutions?
- How can green infrastructure support Atlantic Gateway aspirations and deliver aspects of "Adapting the Landscape" or successor plans?
- How can green infrastructure planning and delivery assist in improving the water quality of the River Mersey and its tributaries?
- Where are the cross-boundary transport routes and major gateways that lead to key investment areas and how can they be enhanced?
- Are there green routes that lead from residential to key investment areas (see also Access) which could increase opportunities for walking and cycling?
- How can the green infrastructure sector be developed - more jobs, safeguarding business, increasing opportunities, increasing skill levels

Evidence overview

There is evidence that business investment decisions are affected by the quality of green infrastructure. In one study 35% of investors identified the quality of the natural

[86] Liverpool and Wirral Waters Enterprise Zones - www.communities.gov.uk/news/corporate/1872164
https://www.gov.uk/government/news/first-4-new-generation-enterprise-zone-locations-identified
[87] http://www.liverpoolvision.co.uk/news/greenprint_for_growth.aspx

- One public opinion survey finding that "82% of residents believed that high quality green parks encourage people and businesses to locate in an area. 98% of people believe that trees and green spaces can improve the appearance of a town"[88];
- Over 35% of companies relocating to SW England quoted environmental attractiveness as a key reason for their move [89];
- "33% of companies relocating to the West Midlands considered attractiveness of the environment as being a key influence on their investment an area. an important factor in their location decision"[90];

High quality gateways to the city: Visual amenity of green space can create attractive gateway to the city, which is often a key first impression for investors. Pleasant journeys to and from work also contribute to a higher quality of life of residents.[91] In the US, drivers' preference for roadsides increased with increased vegetation and greater height and density of trees, in particular those that screened adjacent commercial land uses[92,93]. Commercial developments alongside major roads leading to the city, which contain trees, are generally preferred to both the developments without trees and the undeveloped agricultural land without trees.[94] In the UK, green commuting routes are preferred: the willingness to pay for woodland views on journeys to and from home has been estimated at £226.56 per annum per household (2003 prices).[95]Previously, a study looking at improving these routes "New Approaches" identified a number of key sites for intervention to improve image, many of these interventions involved green infrastructure improvements.[96]

Attracting investment and increasing employment: The presence of high quality green space can improve the 'investability' of an area and its competitiveness as a business location.[97] A survey of real estate developers and consultants across Europe found that 95% of respondents believe that open space adds value to commercial property and would be willing to pay at least 3% more to be in close proximity to open space.[98] An example in returned investment in green infrastructure can be seen in Riverside Park Industrial Estate in Middlesbrough, where extensive planting of trees helped to create a setting for stimulating business growth, which attracted new, high profile, occupants; increased occupancy from 40% to 78%; levered over £1 m of private investment; and saw 28 new businesses and more than 60 new jobs.[99] Landscaping improvements in Portland Basin, Tameside and Winsford, Cheshire, yielded respectively over 16% and 13% of net growth in employment.[100]

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88 GreenSpace (2007) The Park Life Report. Available at: http://www.green-space.org.uk/downloads/ParkLifeReport/GreenSpace%20Park%20Life%20Report%20-%20Sector.pdf
89 Gripaios, P. (1996) The South West Economy: trends and prospects 1995. Plymouth Business School, Plymouth
90 Advantage West Midlands, the Environment Agency and Regional Partners in the West Midlands (2001) The Environmental Economy of the West Midlands. Available at: http://www.rspb.org.uk/Images/env_wms_full_tcm9-133043.pdf
91 Regeneris Consulting (2009).) The Economic Contribution of The Mersy Forest's Objective One-Funded Investments. Available at: http://www.merseyforest.org.uk/files/Economic%20Contribution%20report%20and%20appendices.pdf
92 Wolf KL, K.L. (2003) Freeway roadside management: the urban forest beyond the white line. Journal of Arboriculture 29(3): 127-136.
93 Sullivan WC &, W.C. and Lovell ST, S.T. (2006) Improving the visual quality of commercial development at the rural-urban fringe. Landscape and Urban Planning 77: 152-166.
94 See Sullivan and Lovell (2006)
95 Garrod GD, G.D. (2003) Landscape Values of Forests. Social & Environmental Benefits of Forestry Phase 2, Report to the Forestry Commission, Edinburgh. Centre for Research in Environmental Appraisal and Management, University of Newcastle upon Tyne.
96 TEP (2003) New Approaches. MEAS
97 CABE (2004) The Value of Public Open Spaces. Commission for Architecture and the Built Environment, London.
98 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
99 CLES POLICY ADVICE. Policy Advice (2007.) The Contribution of the Local Environment to the Local Economy presented to Groundwork UK.
100 See CLES Policy Advice (2007)

Green environment for retail: Green infrastructure can play a role in creating a pleasant environment in city centres that increases the footfall and revenue in retail areas. In an US study, presence of trees in central business districts was tied to more positive consumer experiences and a willingness to pay higher prices for goods and services (by ~11%).[101]

Attracting and retaining skilled and productive workforce: Quality of life is becoming an increasingly important consideration in modern business location decisions, in particular for high-tech and knowledge industry, and cities with attractive parks and natural surroundings are more likely to attract knowledge workers[102]. In particular for small businesses and individuals on high salaries, the quality of life becomes more important than remuneration[103]. Greener settings not only attract but also help to retain workers; businesses located next to just regenerated Glasgow green recorded improve staff morale and staff retention rates due to the attractiveness of the location[104]. Green infrastructure also improves productivity: office workers who enjoyed natural view out of the window reported fewer physical ailments and greater job satisfaction compared to those workers without a view.[105] Even the presence of office plants may increase the speed of completing tasks, lower the levels of stress and improve attention.[106]

Higher property prices in greener areas: In London wards, on average a 1% increase in the amount of green space can be linked to a 0.3-0.5% increase in average house price[107]. In North West England, a view of a natural landscape added up to 18% to property, and residents in peri-urban settings are willing to pay £7,680 per household for views of broadleaved woods[108]. The development of a community woodland on the former Bold Colliery site in St Helens has enhanced existing property values in the surrounding area by £15 million[109]. In Aberdeen, properties next to the park can attract a premium of 0.4%-19% compared to a property located 450 m away from a park[110]. Trees have been reported to add between 4-25% to the total value of property, depending on their size, condition, location and species[111, 112].

Green infrastructure can help to tackle the difficult issues that lead to "Pinch Points", areas where investment may be restricted[113]. This restriction may be due a range of issues, air pollution, image, flood risk, noise, negative impacts on biodiversity and landscape. Green infrastructure can offer solutions to these issues, enabling sustainable development.

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101 Wolf KL, K.L. (2003) Public response to the urban forest in inner-city business district. Journal of Arboriculture 29(3): 117-126.

102 Crompton JL, J.L. (2007) Competitiveness: Parks and Open Space as Factors Shaping a Location's Success in Attracting Companies, Labor Supplies, and Retirees in de Brun C (Ed.) The economic benefits of land conservation. The Trust for Public Land, pp.48-54.

103 See Crompton (2007)

104 Gen Consulting (2006) Glasgow Green Renewal Benefits Analysis. A report to Glasgow City Council. Gen Consulting, Glasgow.

105 Kaplan, R. (1993) The role of nature in the context of the workplace. Landscape and Urban Planning 26: 193-201.

106 Lohr VI,, V.I., Pearson-Mimms CH &, C.H. and Goodwin GK, G.K. (1996) Interior plants may improve worker productivity and reduce stress in a windowless environment. Journal of Environmental Horticulture 14: 97-100.

107 GLA Economics (2003) Valuing greenness: Green spaces, house prices, and Londoners priorities. GLA Economics, London.

108 Cousins and Land Use Consultants (2009) Economic contribution of green networks: current evidence and action. North West Development Agency, Manchester.

109 Forestry Commission (no date) Bold Colliery Community Woodland. District Valuer's report on Property Values. Forestry Commission

110 Dunse, N,., White, M &. and Dehring, C. (2007) Urban parks, open space and residential property values. RICS Research Paper Series. RICS, London.

111 Regeneris Consulting (2009) The Economic Contribution of The Mersy Forest's Objective One-Funded Investments. Available at: http://www.merseyforest.org.uk/files/Economic%20Contribution%20report%20and%20appendices.pdfhttp://www.merseyforest.org.uk/pages/displayDocuments.asp?iDocumentID=246

112 CTLA (2003) Summary of tree valuation based on CTLA approach. Council of Tree and Landscape Appraisers.

113 The Mersey Forest (2008) Green Infrastructure Solutions to Pinch Point Issues in North West England, Available at: http://www.ccinw.com/uploads/documents/green_infrastructure/green_infrastructure.pdf

Creating safe, attractive routes that link green routes, parks and open spaces with the wider public realm can encourage both walking and cycling, particularly where these routes link homes to key local services such as shops, GP surgery and places of work[114]. These help to improve health and productivity.

Air and Water Quality

Air pollution harms human health and the environment and has an impact on the economy through for instance days lost through sickness. More detailed assessment of the health impacts of poor air quality is provided in the section on health below. DEFRA advise that air quality impacts making should be reflected where possible in of investments and decision making in line with HM Treasury's Green Book guidance.

Health and Wellbeing

There is an important link between the general health and wellbeing of potential and actual employees and the economy.

For example it has been suggested that poor mental health is on the increase and that successful treatment will raise the employability of recovers, and hence the human capital of the economy; In turn this new human capital may generate multiplier effects in the economy so that the benefits may exceed the exchequer gains of those regaining or retaining employment themselves.[115]

[115] Layard, R., Clark, D., Knapp, M. And Mayraz, G. .(2007) CEP Discussion Paper No 829. Cost-Benefit Analysis of Psychological Therapy. Centre for Economic Performance, London School of Economics, London. Available at: http://eprints.lse.ac.uk/19673/1/Cost-Benefit_Analysis_of_Psychological_Therapy.pdf

Recreation, Access and Tourism

Issues

The current financial situation is putting a great deal of pressure on the maintenance of existing areas of public open space within the green infrastructure network.

Increasing population levels will require additional open space for recreation and leisure. Providing accessible green spaces close to people has important impacts on several of the other Framework priorities, helping to improve quality of place, reducing the need to travel, creating a place for exercise and providing habitat and corridors for wildlife.

The city region coastal areas are already a key tourism destination and have the potential to attract more visitors provided that the quality of the resort and from a green infrastructure perspective the bathing waters are maintained or improved.

Projected climate and demographic change may also mean that patterns of use of recreational routes and open space will change. Warmer weather may lead to increased use of sites, but only if they are of a suitable standard, safe and open for use.

The projected increases in fuel prices may also lead to more pressure on local areas for both short and medium term breaks, recreation and leisure.

There is potential for significant development of improved cycle and bridleway networks and three Forest Parks have been identified in the city region and Warrington.

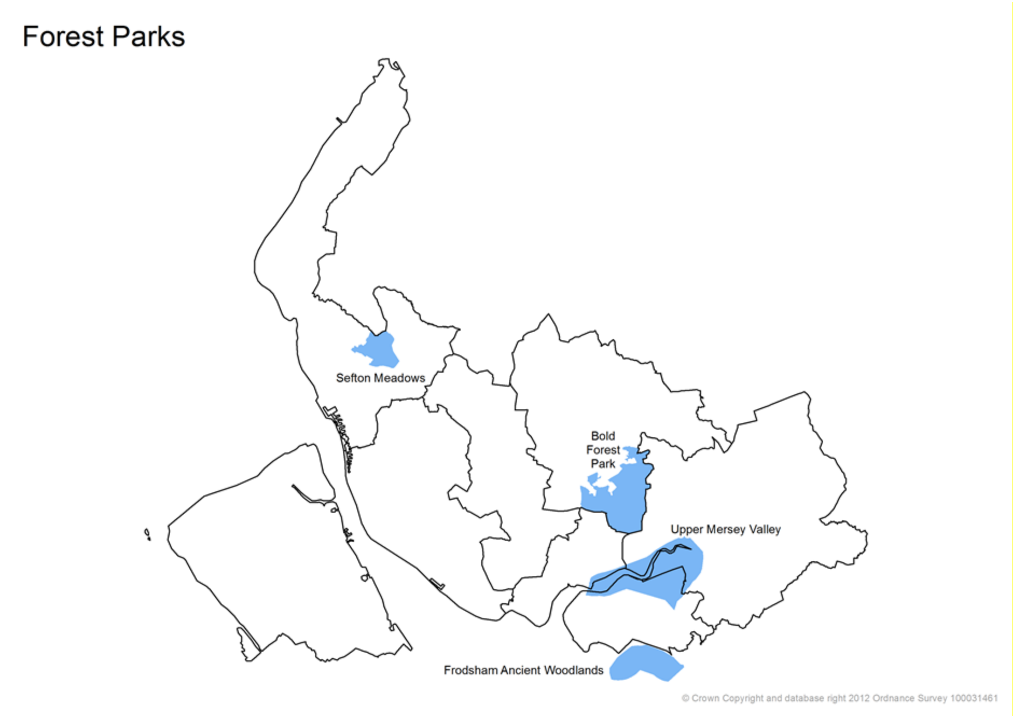

Figure 25 Forest Parks

Many of the city region areas of green infrastructure are already tourism destinations in their own right, for example Knowsley Park and Sefton Coast, and attract hundreds of thousands of visitors each year. These areas are also secondary destinations for those visiting Liverpool or other large towns in the city region.

Key Questions

- Where in the city region are the Access to Natural Green Space targets (ANGSt) not achieved, and how may this change given proposed housing growth and projected population growth?
- What opportunities exist for cross-boundary cooperation on the provision of open space for recreation?
- What future potential can be fulfilled by the key strategic access routes such as the Trans Pennine Trail, Sankey Valley and coastal trails?
- Are there any key routes to be developed to enable increased/improved green (non-motor) travel between areas of housing and commercial areas?
- Where are the woodlands that play a key cross-boundary role and how do they meet Woods for People standards?

Evidence overview

A major recreation resource: Over 40% of people in England visit parks at least once a week, and only 7% never use parks[116]; 87% of the population use their local parks or open spaces regularly[117].Urban parks in England are estimated to receive 2.6 billion visits a year[118], making parks the most frequently used public service[119].The majority of the public believe that parks and open spaces improve their quality of life (90%) and that they are important to physical and mental well-being (74%)[120].

This is illustrated by activities in parks: the main reasons for visiting the Royal Parks in London are 'for a walk or stroll' (54%), 'for fresh air' (33%) and 'peace and quiet' (25%), the average visit taking 72 minutes[121]. In a survey in Amsterdam, nearly three-quarters of the respondents went to parks to relax and 54% to listen and observe nature[122]. Sport is an important activity: for example, Leicester's urban green spaces were found to support 1,985 team games a year involving 54,249 men and 1,136 women[123].

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116 CABE (2010) Urban green nation: Building the evidence basis. Commission for Architecture and the Built Environment, London.
117 DCLG (2008) Place Survey: England, Department of Communities and Local Government London
118 Dunnett, N, Swanwick, C &. and Woolley, H. (2002) Improving urban parks, play areas and green spaces. Department for Transport, Local Government and Regions, London.
119 See CABE (2010)
120 CABE (2004) Public Attitudes to Architecture and Public Space: Transforming neighbourhoods. Commission for Architecture and the Built Environment, London.
121 Synovate (2009) The Royal Parks in-park research report 2009 – All parks combined. The Royal Parks, London.
122 Chiesura, A. (2004) The role of urban parks for the sustainable city. Landscape and Urban Planning 68: 129-138.
123 See Dunnett et al. (2002)

However, people over 65, the disabled, black and ethnic minorities, women and 12-19 year-olds use parks less frequently[124]. Whilst less than 10% of people in the UK do not visit parks for fear of their personal safety[125], research shows that this disproportionately affects these groups[126].

Proximity of green space: The majority of visits to green spaces are made on foot,[127,128] and most people would walk to a green space no longer than five minutes.[129,130] In the Netherlands, people were found to prefer smaller green spaces close to home, rather than a large green space further away.[131]The 'walkable' distance to green spaces that majority of the population would be willing to travel has been identified as circa 300m.[132] The importance of presence of green spaces within 300m distance from one's dwelling has been stressed by the Accessible Natural Green space Standard[133]. However, in majority of the UK cities, only a small proportion of people live within this distance from a green space: this was the case in Sheffield (36.5% of people lived close to parks) [134]and Leicester (10.3% close to a green space over 2 ha).[135] Moreover, the distribution of green space is unequal: the most affluent 20% of wards in England have five times the amount of parks or general green space than the most deprived 10% of wards. Areas which are more than 98% white have 6 times as many parks as wards which are 40% non-white.[136]

Quality of green space: Surveys suggest that the following make for a good quality green space: vegetation and water, play opportunities, seating, toilets and shelters, good access, sport, and events[137,] which give a sense of community, and allow for relaxation, escapism and contact with nature[138]. The main issues negatively affecting the use of green spaces are lack or poor condition of facilities; other users, including undesirable characters; concerns about dogs/dog mess; safety; litter, graffiti and vandalism.[139,140,141]

Tourist attraction: Whilst many of the tourist attractions in cities and towns are built heritage, they are often located within in historic parks which contribute to their aesthetic value[142]. The Royal Parks in London are a popular tourist attraction all year round and a quarter of their visitors come from outside the UK. The visitors thought that more events related to music, theatre,

[124] Urban Green Spaces Task Force (2002) Green Spaces. Better Places. Local Government and The Regions, London.
[125] *CABE (2005) Decent parks? Decent Behaviour? Commission for Architecture and the Built Environment, London.*
[126] Madge, C. (1997) Public parks and the geography of fear. *Tijdschrift voor economischeTijdschriftvooreconomische en socialegeografie,* 88: 237-250.
[127] Forestry Commission (2010) Forestry statistics 2010. Forest Commission, Edinburgh.
[128] Pauleit, S. Slinn, P.Handley, J. and Lindley, S. (2003) Promoting the natural greenstructure of towns and cities: English Nature's Accessible Natural Greenspace Standards Model. Built Environment 29: 157-170.
[129] Ravenscroft, N. and Markwell, S. (2000) Ethnicity and the integration and exclusion of young people through urban park and recreation provision. Managing Leisure 5: 135-150.
[130] Coles, R &. and Bussey, S. (2000) Urban forest landscapes in the UK - progressing the social agenda. Landscape and Urban Planning 52: 181-188.
[131] Al, E &. and Kuiper L (2000) *Dutch Woodlands.* Stichting ProBos, Zeist.
[132] Harrison, C, Burgess, J, Millward, A &. and Dawe, G. (1995) Accessible natural greenspace in towns and cities: A review of appropriate size and distance criteria. English Nature Research Report No 153. English Nature, Peterborough.
[133] English Nature (2003) Accessible green space standards in towns and cities: A review and toolkit for their implementation. English Nature Research Report No 526. English Nature, Peterborough.
[134] Barbosa, O,., Tratalos JA,, J.A., Armsworth PR,, P.R., Davies RG,, R.G., Fuller RA,, R.A., Johnson, P &. and Gaston KJ, K.J. (2007) Who benefits from access to green space? Landscape and Urban Planning 83: 187-195.
[135] Comber, A,., Brundsdon, C &. and Green, E. (2008) Using a GIS-based network analysis to determine urban greenspace accessibility for different ethnic and religious groups. Landscape and Urban Planning 86: 103-114.
[136] CABE (2010) CABE (2010) Urban green nation: Building the evidence basis. Commission for Architecture and the Built Environment, London.
[137] Dunnett et al (2002) Dunnett, N., Swanwick, C. and Woolley, H. (2002) Improving urban parks, play areas and green spaces. Department for Transport, Local Government and Regions, London.
[138] CABE Space (2005) Parks and squares: who cares? Commission for Architecture and the Built Environment, London.
[139] See Dunnett et al. (2002)
[140] ENCAMS (2006) A guide to improving your local environment. ENCAMS, Wigan.
[141] See CABE Space (2005)
[142] Davies, L,., Kwiatkowski, L,., Gaston KJ,, K.J., Beck, H,., Brett, H,., Batty, M,., Scholes, L,., Wade, R,., Sheate WR,, W.R., Sadler, J,., Perino, G,., Andrews, B,., Kontoleon, A,., Bateman, I . and Harris JA, J.A. (2011) Urban In: The UK National Ecosystem Assessment Technical Report. UK National Ecosystem Assessment, UNEP-WCMC, Cambridge

nature, history, and guided walks and tours would make the parks even more attractive.[143] Regarding other green spaces, 317 million trips were made to woodland or forest in 2009-10.[144] However, whilst 24% of the respondents to the England Leisure Visits Survey visited the countryside, the coast, a national park or an area of open access land in the week before the survey, over 40% of the adult population in England does not visit countryside at all[145]. In particular, the low income groups, young adults, ethnic minorities and the disabled rarely visit the countryside[146].

[143] Synovate 2009 Synovate (2009) The Royal Parks in-park research report 2009 – All parks combined. The Royal Parks, London.
[144] Forestry Commission (2010) Forestry statistics 2010. Forest Commission, Edinburgh.
[145] Natural England (2005) England Leisure Visits. Report of the 2005 Survey. Natural England., Peterborough.
[146] Slee, B. (2002) Social exclusion in the countryside. Countryside Recreation 10: 2-7.

Climate change

Issues

The city region needs to mitigate its production of greenhouse gases, decoupling planned growth from emissions and transforming to a low carbon economy and also, importantly adapting to the projected changes that are already built into the climate system through the already elevated levels of greenhouse gases in the atmosphere.

Data from UKCP 09[147] projects that climate change will mean that the Liverpool City Region will face a number of challenges including:

- Hotter, drier summers, requiring an increased focus on water management
- Wetter winters potentially leading to increases in flood damage
- More extreme events, including storm and drought that can lead to damage to property and present risks to communities.

The recently published City Region Green Infrastructure and Climate Change Framework provide an extensive assessment of actions that are required within the city region. This green infrastructure framework assesses what actions need to be addressed cross boundary and collectively.

Key Questions

- What are the key cross boundary actions from climate change work completed for the city region and Warrington to date?

- What is climate change functionality in relation to of the green infrastructure near to critical grey infrastructure (emergency plans)? At a city region level?

- How can green infrastructure help to deliver aspects of the sub regional low carbon economy plans?

- Where are the most vulnerable areas of the city region and Warrington-is the area resilient to projected climate change for impacts on:

    - Health - vulnerable communities
    - Economy - damage to property/investment
    - Ecology - species migration and existence habitat loss

Evidence overview

The Intergovernmental Panel on Climate Change states that the warming of the global climate system is now unequivocal. Whilst coherent changes can be seen in many aspects of the climate system, the temperature change observed in the last 50 years is very likely (>90% chance) due to increases in man-made greenhouse gas concentrations[148].

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147 http://www.ukcip.org.uk/
148 IPCC (2007) Climate Change 2007: The Physical Science Basis, Summary for Policymakers. www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf IPCC (2007) Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, USA.. Available at: www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf

There is a recognised international and national need for both climate change mitigation and adaptation. Mitigation involves reducing greenhouse gas emissions and concentrations. It is a vital response as the greater the reduction of emissions and concentrations of greenhouse gases, the less severe the negative impacts of climate change will be. However, some of the changes we will experience over the next 30-40 years are now inevitable as they have already been determined by historic greenhouse gas emissions[149]. Alongside mitigation, society must also adapt to the impacts of climate change.

There are a number of services provided by green infrastructure which can help with both mitigation and adaptation (Figure 26); the adaptation services provided by green infrastructure may be the more substantial. These services are described and evidence for them presented in a recent report for Northwest England[150]. Additional evidence for some of the services is set out below.

Figure 26 Climate change mitigation and adaptation services provided by green infrastructure

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

Managing high temperatures

Green infrastructure has the potential to help urban areas cope with increased temperatures, by providing evaporative cooling and shading. Trees with large mature canopies are especially important for their shade provision. Open spaces which allow air to flow through the city could also help to manage high temperatures; Berlin's digital environmental atlas emphasises the importance of air flows through the city, with planning advice for different areas[151].

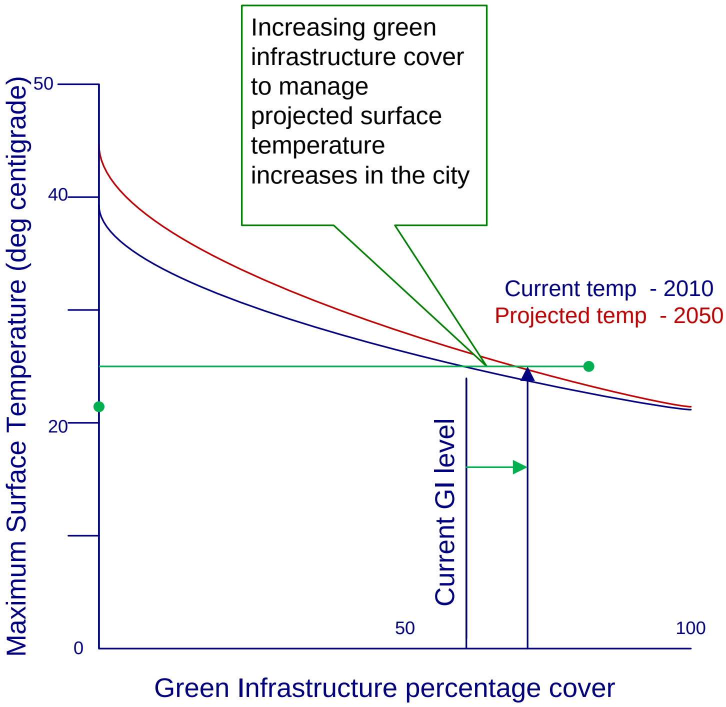
Surface temperature has been shown to vary with levels of green infrastructure cover[152].
Figure 27illustrates the relationship between green infrastructure cover and maximum surface temperature, using both current climate data and climate change projections. Surface temperature, rather than air temperature, is used here as a proxy for the temperature that people sense in a particular area, and so how comfortable they feel.

As green infrastructure increases, the maximum surface temperature reduces, providing a mechanism for planners and urban designers to take some control of the impacts of projected climate change on the comfort of the city for residents and visitors. If temperature is to be maintained at a comfortable level, the area of green infrastructure will need to be increased.

149 Hulme, M., Turnpenny, J. And Jenkins, G..(2002) Climate Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report. UK Climate Impacts Programme. www.ukcip.org.uk Available at: http://www.ukcip.org.uk/wordpress/wp-content/PDFs/UKCIP02_briefing.pdf
150 CFNW (2010) Green Infrastructure: How and where can it help the Northwest mitigate and adapt to climate change. Available at: http://www.ginw.co.uk/climatechange
151 www.stadtentwicklung.berlin.de/umwelt/umweltatlas/edua_index.shtml Berlin Environmental Atlas. Available at: www.stadtentwicklung.berlin.de/umwelt/umweltatlas/edua_index.shtml
152 Gill, S. (2006). Climate change and urban green space. PhD thesis completed as part of the ASCCUE project, University of Manchester. Available at: http://www.ginw.co.uk/resources/Susannah_PhD_Thesis_full_final.pdf

By increasing the amount of green infrastructure, moderation of increasing temperatures with climate change could be achieved. For example, our mapping suggests that the evaporative cover of Liverpool Knowledge Quarter is 30%, therefore to maintain surface temperatures at levels similar to present day hot periods green infrastructure must be increased by 10%.

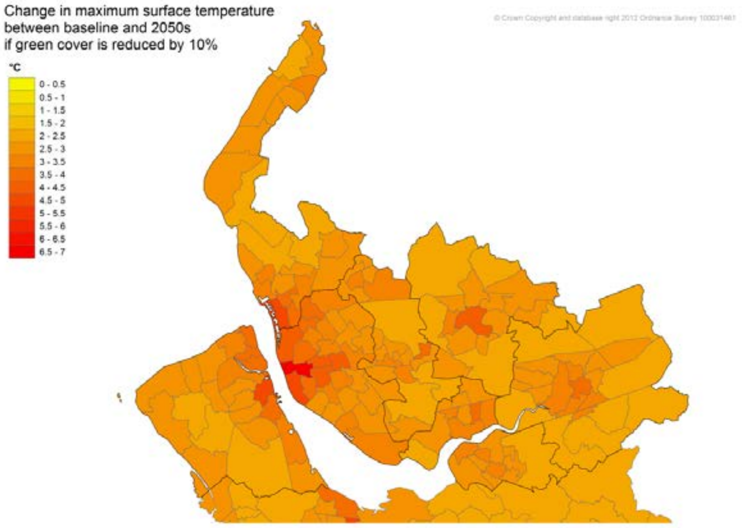
Figure 27 Relationship between green infrastructure and maximum surface temperature



The GRaBS Interreg Project developed an online assessment tool (STARS tool) that can be used to evaluate future maximum surface temperatures based on this model and the assessment of current green infrastructure. Star Tools[153] has been used to calculate temperature values for the city region and Warrington based on UK Climate Change projections.

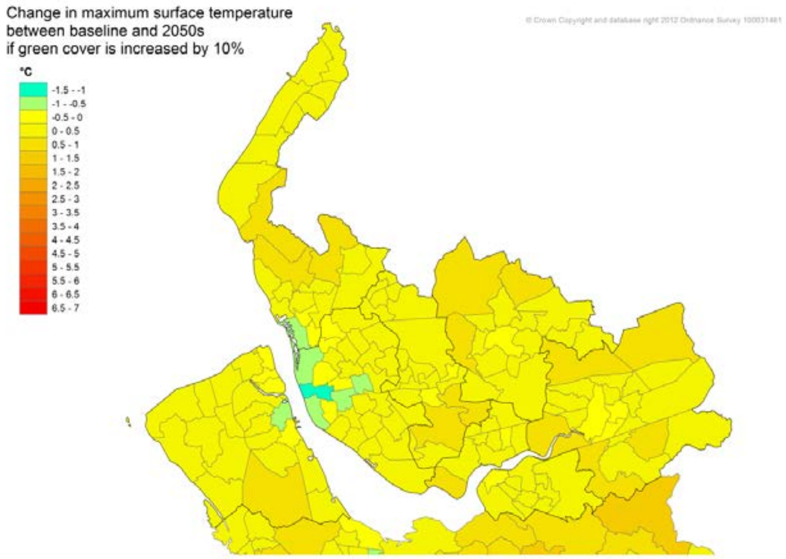
STAR tools were run to show the impact of increasing or decreasing green cover on maximum surface temperature across the city region and Warrington.

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



Decreasing green cover by 10% increases Maximum Surface Temperature across all areas, but the increase is particularly significant in urban areas. This is important for day and night time comfort and is linked to incidence of overhearing and potentially heat wave induced deaths as seen in 2003 and 2006. Birkenhead and Liverpool's coastal location reduces the impact, but only on days where there is a breeze. Other areas such as Warrington and St Helens town centres, Kirkby also see significant temperature rise.

In contrast increasing cover by 10% keeps temperatures close to the current levels.



Grassed surfaces in tree shade can be 15-20°C cooler than tarmac exposed to sun, and the air temperature in tree shade can be 5-7°C lower than in the sun.[154]Urban parks with dense vegetation are on average 1°Ccooler than built up areas during the day[155]. Research in Manchester suggests that a 10% increase of green space in densely built-up areas would reduce the urban heat island effect by 2.2-2.5% and would help to maintain the current temperatures at the end of the 21st century.[156]

Using green infrastructure to manage high temperatures helps to reduce heat stress and mortality, particularly in vulnerable communities. It also ensures that cities continue to be comfortable places to live, work, visit and invest in the future. It should be noted that green infrastructure responses which help to manage high temperatures, can also help mitigate climate change by reducing energy use for cooling buildings.

Urban areas display an 'urban heat island' effect, where they are warmer than the surrounding countryside. It is here where green infrastructure can make the biggest impact in terms of helping manage high temperatures. This is especially where vulnerable people live, where green infrastructure levels are currently lowest, and in areas where people congregate.

In the Northwest, there were approximately 60 excess deaths in the heat wave of July 2006; this is approximately 15% above the baseline[157]. By the 2080s, it is predicted that a heat wave similar to that experienced in England in 2003 will happen every year. The NHS Heat wave Action Plan[158] sets out long term planning to increase green infrastructure as a key action to help to reduce the impacts of heat waves. It identifies the factors which make people more vulnerable to increased temperatures as:

- Older age: especially women 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. Medications that potentially affect renal function, the body's ability to sweat, thermoregulation or electrolyte balance can make this group more vulnerable to the effects of heat.
- Inability to adapt behaviour to keep cool: having Alzheimer's, a disability, being bed bound too much alcohol, babies and the very young.
- Environmental factors and overexposure: living in urban areas and south facing top floor flats, being homeless, activities or jobs that are in hot places or outdoors and include high levels of physical exertion.

Carbon storage and sequestration: Around 36.6 billion tonnes of potential CO_2 are stored in UK soils. Grassland and arable soils provide the largest storage (due to their overall size)[159]. However, peatlands contain the highest concentrations of carbon and degraded peatlands

[154] Ennos, R. (2011) Quantifying the cooling and anti-flooding benefits of green infrastructure. Available at: http://www.sed.manchester.ac.uk/architecture/research/ecocities/news/documents/UoM_Roland_Ennos.pdf.
[155] Bowler DE,, D.E., Buyung-Ali, L,., Knight TM, T.M. and Pullin AS, A.S. (2010) Urban greening to cool towns and cities: A systematic review of the empirical evidence. Landscape and Urban Planning 97: 147-155.
[156] Gill SE,, S.E., Handley JF,, J.F., Ennos AR &, A.R. and Pauleit, S. (2007) Adapting cities for climate change: the role of the green infrastructure. Built Environment 33: 115-133.
[157]NHS (2010) Heatwave Plan for England. NHS, London.
http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@en/@ps/documents/digitalasset/dh_1144 23.pdf
[158] See 149
[159] Bradley RI,, R.I., Milne, R,., Bell, J,., Lilly, A,., Jordan, C &. and Higgins, A. (2005) A soil carbon and land use database for the United Kingdom. Soil Use and Management 21,: 363-369.

release 2.8-5.8 million tonnes of carbon a year, making peat restoration a priority[160]. Saltmarshes are important for carbon storage and sequestration: returning 26 km^2 of coastal land to intertidal area in Humber Estuary could result in storing about 800 tonnes of organic carbon and 40 tonnes of non-organic carbon.[161]The UK woodlands currently only hold as much carbon as the UK emits in one year of fossil fuel burning; however, an enhanced woodland creation programme involving planting 23,200 hectares could deliver abatement of approximately 15 mega tonnes of CO_2 per year by the 2050s[162](10% of projected emissions at that time)[163]. Better management of woodland for fuel and timber can also reduce carbon emissions: wood fuel is carbon neutral and timber can replace fossil fuel based products, such as building materials[164].

Natural cooling and insulation: Green roofs act as effective insulators[165], reducing the requirement for both heating and air-conditioning. A study on wind sheltering by trees of a two storey office building in Scotland predicted a reduction of 400 kg/floor area on CO_2 emissions (if natural gas was used for the heating). [166]

Reduced car travel: A study in Maastricht shows that the more parks people had within their neighbourhood, the more their commuted by bicycle[167]. In the UK, from a survey of 5844 respondents, 78% agreed with the statement 'Improved traffic free footpaths and cycle routes would encourage me to walk or cycle'.[168]

Local food growing initiatives: About 50% of food consumed in the UK is from countries outside the UK[169] and nearly 90% of the UK's fruits are imported[170]. Food transportation accounts for one quarter of all UK HGV vehicle mileage, and 10 M tonnes of CO_2 were emitted in the UK in 2002 as a direct result of food transportation[171]. A typical allotment plot for growing soft fruits, root vegetables, legumes, leafy greens and alliums provides a saving of approximately 1.5kg CO_2/m^2.[172]

Adaptation

Managing runoff: Green infrastructure intercepts, infiltrates, stores and evaporates rainwater, thereby reducing the rate and volume of water entering drains and limiting the risk of them being overwhelmed during extreme rainfall. Runoff can be reduced by 60% by trees over hard surfaces

160 Thompson, D. (2008) Carbon Management by Land and Marine Managers. Natural England, Peterborough.
161 Downing JA,, J.A., Cole JJ,, J.J., Middelburg JJ,, J.J., Striegl RG,, R.G., Duarte CM,, C.M., Kortelainen, P,., Prairie YT &, Y.T. and Laube KA, K.A. (2008) Sediment organic carbon burial in agriculturally eutrophic impoundments over the last century. Global Biogeochemical Cycles 22, GB1018.
162 Read DJ,, D.J., Freer-Smith PH,, P.H., Morison JIL,, J.I.L., Hanley, N,., West CC &, C.C. and Snowdon, P. (2009) Combating climate change - a role for UK forests. An assessment of the potential of the UK's trees and woodlands to mitigate and adapt to climate change. TSO, Edinburgh.
163 Broadmeadow, M. and Mathews, R. (2003) Forests, Carbon and Climate Change: the UK Contribution. Forestry Commission, Edinburgh.
164 See Broadmeadow and Matthews (2003()
165 Kumar, R &. and Kaushik SC, S.C. (2005) Performance evaluation of green roof and shading for thermal protection of buildings. Building and Environment 40, 1505-1511.
166 Wang, F,., Hunt, T,., Liu, Y,., Li, W &. and Bell, S. (no date) Reducing Space Heating in Office Buildings Through Shelter Trees. Available at: http://www.cibse.org/pdfs/8cwang.pdfhttp://www.cibse.org/pdfs/8cwang.pdf.
167 Wendel-Vos, W,., Schuit AJ,, A.J., De, Niet, R., Boshuizen HC,, H.C., Saris, W &. and Kromhout, D. (2004) Factors of physical environment associated with walking and bicycling. Medicine and Science in Sports and Exercise 36: 727-730.
168 GreenSpace (2010) GreenSTAT visitor survey system.
169 Food Standards Agency (2010) Working together on imported food. FSA, London.
170 Ministry of Agriculture, Forestry and Fisheries (1998) Basic horticultural statistics for the United Kingdom: calendar and crop years 1987-1997. MAFF, London.
171 Department for Environment Food and the Rural Affairs (2005) A government report: The validity of food miles as an indicator of sustainable development. DEFRA, London.
172 Elbourne P (2009) Reducing food-related greenhouse gas emissions through local production of fruit and vegetables. Community Powerdown. Available at: http://www.communitypowerdown.org.uk/userfiles/file/documents/Deliverables/Local_Food_Production/Peter%20Elbourne%20-%20Local%20Food%20Production%20GHG%20Savings.pdf

and by nearly 100% by grassland[173]. A hectare of grassland and broadleaved woodland in the UK can evaporate, respectively, 3.4 and 4.0 million litres of water[174].Modelling conducted on Manchester shows that adding 10% of green space can reduce runoff by 5-6%, and adding green roofs to all buildings in densely built-up areas could reduce runoff by 17.0-19.9%.[175] Forestry Commission and the Environment Agency published a study[176] to look at how woodland can help to achieve Water Framework Directive objectives, including reducing runoff and soil erosion and flood alleviation. The study reported that there was significant scope for using woodland to help reduce flood risk. In particular flood plain and riparian woodlands were identified as valuable for attenuating flooding in downstream towns and cities.

Reducing the risk of river and coastal flooding: Trees increase the capacity of the soil to absorb water; a study in Wales found that infiltration rates were up to 60 times higher within native woodland compared to grazed pasture[177];planting shelterbelts across the lower parts of grazed grassland sites could reduce peak flows by 13-48%[178]. A modelling study in Somerset showed that planting woodland along a 2.2 km grassland reach of the River Cary could reduce water velocity by 50%, increase the temporary water retention by 71% and delay the downstream progression of the flood peak by 140 minutes.[179] Salt marshes dissipate the wave energy before it reaches the shore: it has been estimated that an 80m wide zone of inter-tidal habitat fronting sea walls can save £4,600 per metre in sea defence costs.[180]

Maintaining sustainable water supplies: Sustainable Urban Drainage Systems can also help to increase aquifer recharge through porous paving systems and detention ponds allowing water to reach the soil[181].

Helping other species to adapt

As the climate changes, the range of species may shift northwards and upwards to higher altitudes as they seek new 'climate spaces'. A number of factors will limit their ability to do this, including their own dispersal ability and the nature of the landscape through which they are moving (i.e. the fragmentation of existing habitats and the permeability of the landscape between

173 See Ennos (2011) Ennos, R. (2011) Quantifying the cooling and anti-flooding benefits of green infrastructure. Available at: http://www.sed.manchester.ac.uk/architecture/research/ecocities/news/documents/UoM_Roland_Ennos.pdf

174 Hölzinger, O. (2011) The Value of Green Infrastructure in Birmingham and the Black Country. The Total Economic Value of Ecosystem Services provided by the Urban Green Infrastructure. The Wildlife Trust for Birmingham and the Black Country.

175 See Gill et al. (2007) Gill, S.E., Handley, J.F., Ennos, A.R. and Pauleit, S. (2007) Adapting cities for climate change: the role of the green infrastructure. Built Environment 33: 115-133.

176 ADAS and Forest Research (2010,) Woodland and the Water Framework Directive, Forestry Commission and Environment Agency.

177 Bird SB,, S.B., Emmett BA,, B.A., Sinclair FL,, F.L., Stevens PA,, P.A., Reynolds, A,., Nicholson, S &. and Jones, T. (2003) PONTBREN: Effects of tree planting on agricultural soils and their functions. Centre for Ecology and Hydrology, Bangor, Gwynedd.

178 Jackson BM,, B.M., Wheater HS,, H.S., McIntyre NR,, N.R., Chell, J,., Francis OJ,, O.J., Frogbrook, Z,., Marshall, M,., Reynolds, B. and Solloway, I. (2008) The impact of upland land management on flooding: insights from a multiscale experimental and modelling programme. Journal of Flood Risk Management 1: 71-80.

179 Thomas, H. and Nisbet TR, T.R. (2006) An assessment of the impact of floodplain woodland on flood flows. Water and Environment Journal 21: 114-126

180 Collins, T,., Empson, B,., Leafe, R &. and Lowe, J. (1997) Sustainable flood defence and habitat conservation in estuaries - a strategic framework. In Proceedings of the 32nd MAFF Conference of River and Coastal Engineers. University of Loughborough, July 2-4, 1997

181 Carter, T &. and Butler, C. (2008) Ecological impacts of replacing traditional roofs with green roofs in two urban areas. Cities and the Environment 1: 9-17.

habitats)[182]. The management of linear features and corridors (e.g. river corridors, and road, railway and canal verges) for species movement may become increasingly important. Features oriented north-south may aid species movement, whereas east-west features could act as barriers unless appropriately designed[183].

A Natural England study assessed and mapped the vulnerability of the Northwest's natural environment to climate change according to character areas. It found that protected landscapes are often the most resilient, whilst areas of highest risk correspond with built up areas and act as a barrier to movement of species through the Northwest[184]. The natural areas of Liverpool City Region and Warrington are identified as having high vulnerability to climate change.

Comment [AK1]: Unfortunately the links to the reports on this website do not work.

Comment [AK2]: The Adobe reader task bar is visible in this screenshot.

Green infrastructure can help other species to adapt to climate change as it provides existing habitats. In addition, action should be taken in areas deemed to be vulnerable to climate change; this could be by creating new habitat to connect fragmented areas, or by increasing the wider landscape permeability through, for example, the planting of appropriate species and management of linear corridors.

A DEFRA commissioned report[185] on adapting to climate change in England suggested the easiest way to help biodiversity move and survive in urban areas is changing the management of close-mown amenity grass and encouraging wildlife-friendly gardening. Adopting a 'light touch' approach helps to improve biodiversity and can significantly reduce the maintenance costs associated with green infrastructure, as this can reduce costs of herbicides, pesticides, fertiliser and labour.

Managing flooding

Projected climate change identifies increased winter rainfall with more intense rainfall events. This will lead to increased river and surface water flooding.

Ageing water infrastructure and the sealing of natural surfaces through paving (see Figure 28 for the impact of surface sealing on hydrology) combined with the projected changing climate increases the risk of flooding. The Foresight report[186] suggested that nationally we may be facing an annual cost of management of £1.4 billion to £70 billion by 2080. The Pitt review[187] identified reducing (or restricting) sealed surfaces along with avoiding new building in flood zones as key recommendations to avoid future flood impacts.

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[182] MONARCH (Modelling Natural Resource Responses to Climate Change) was a seven year phased programme to assess impacts of projected climate change on wildlife in Britain and Ireland. www.ukcip.org.uk/images/stories/Pub_pdfs/Monarch_summary.pdf http://www.ukcip.org.uk/wordpress/wp-content/PDFs/Monarch1_summary.pdf

[183] Personal communication with Dr Anna Gilchrist, University of Manchester.

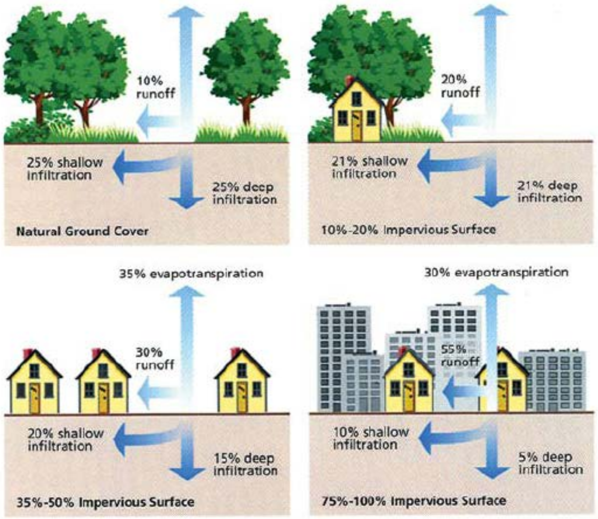
[184] Natural England (2010). An Assessment of the vulnerability of the Natural Environment in the Northwest to climate change at the National Character Area scale. See http://www.naturalengland.org.uk/regions/north_west/ourwork/climatechangeproject.aspx

[185] Mitchell Mitchell, R.J., Morecroft, M.D., Acreman, M., Crick, H.Q.P., frost, M., Harley, M., Maclean, I.M.D., Mountford, O., Piper, J., Pontier, H., Rehfisch, M.M., Ross, L.C., Smithers, R.J., Stott, A., Walmsley, C., Watts, O., Wilson, E.(2007) England biodiversity strategy - towards adaptation to climate change. Final report to DEFRA. Available at: http://nora.nerc.ac.uk/915/1/Mitchelletalebs-climate-change.pdf

[186] Department for Business, Innovation and Skiils (2004) Foresight Future Flooding report. Executive Summary. Available at: http://www.bis.gov.uk/assets/foresight/docs/flood-and-coastal-defence/executive_summary.pdf

[187] Pitt (2008) Learning lessons from the 2007 floods Pitt, M. (2008) Learning lessons from the 2007 floods. An independent review by Sir Michael Pitt. Available at: http://webarchive.nationalarchives.gov.uk/+/http://www.cabinetoffice.gov.uk/upload/assets/www.cabinetoffice.gov.uk/flooding_review/flood_report_web.pdf

Figure 28 Effect of natural and impervious surfaces on the hydrological cycle



The Pitt Review advocates working with natural processes to manage flooding[188]. Green infrastructure in the wider catchment can reduce the frequency of river floods, but in extreme rainfall events this is less significant. Land use management has a significant effect on runoff at local levels; wetlands and riparian and floodplain woodlands help to reduce peak flood volumes, and provide areas where rivers can flood without causing damage[189].

In more urban areas green infrastructure intercepts (especially trees), infiltrate (especially on permeable soils, where water can percolate underground most easily), stores and evaporates rainwater, thereby reducing both the rate and volume of water entering drains. This reduces the chances of them being overwhelmed during extreme rainfall but also reduces the volume of water that needs to be treated. This means that less pressure is placed on the existing water "grey" infrastructure. Surface water should increasingly be managed through Sustainable Urban Drainage Systems (SUDS). Green infrastructure can incorporate SUDS which mimic natural systems to reduce flooding. Some SUDS components include: swales, infiltration trenches and basins, and detention ponds. Green infrastructure should be safeguarded in areas where the soils are most permeable.

Depending on size and species, larger trees have the potential to intercept 80% of precipitation where smaller trees may only have 16% rainfall interception. Generally conifers intercept more water than broadleaved trees with extreme differences during the dormant season when broadleaved trees are leafless. In this time period they intercept only between 10 and 30% of their potential when in leaf.

Vegetation also increases the infiltration rate of soils through roots and the turnover of roots. Research has found that root growth by, for example, trees can increase the infiltration rate of soils by a factor of 2-17. Infiltration rates can increase by 90% within two years after converting grassland into woodlands. Besides increasing the infiltration rate of the soil and therefore

188 See Pitt (2008).http://archive.cabinetoffice.gov.uk/pittreview/thepittreview/final_report.html
189 Handley &, J. and Gill, S. (2009) Woodlands helping society to adapt. In Read et al. (2009) Combating climate change: – a role for UK forests. An assessment of the potential of the UK's trees and woodlands to mitigate and adapt to climate change. The Stationery Office, Edinburgh. Available at: http://www.tsoshop.co.uk/gempdf/Climate_Change_Main_Report.pdf

removing water from the surface and possible runoff from other surfaces vegetation also removes water through water up take.

It is obvious that ponds, rivers and wetlands can store water depending on their width and depth. However, areas such as football fields within a floodplain have the potential to temporarily store storm water and therefore prevent flooding of homes and other buildings.

Ecological Framework

Issues

The Lawton Report (see section 10) has been paraphrased as calling for enhancement to our ecological networks though joined up actions that deliver;

- **More** areas of high biodiversity
- **Bigger** areas, one of the key drivers of biodiversity is habitat size
- **Better** managed sites
- **Joined up** habitats, so that through connected habitats species and gene movement is enabled.

Taken together these actions would also ensure that the functionality and the services that we benefit from are also sustained and improved.

This thinking has been taken forward in the Natural Environment White Paper - The Natural Choice – discussed above.

An area rich in biodiversity is likely to be more resilient and provide us with options for management in the future as we face a wide range of challenges; climate, economic, demographic and ecological.

There has been some debate about the language that is used to describe and communicate the natural environment. Fundamentally green infrastructure, ecosystem services and biodiversity are describing the same thing; but in different languages. The key issue is to use a language that is most understandable to the audience. In this case green infrastructure has been shown to be effective as in communicating both how and where the natural environment can play a role in delivering a wide range of roles for society.

The Liverpool City Region Ecological Framework aims to reduce the fragmentation or loss of important habitats across the City Region. The Framework has identified four key elements.

- Core Biodiversity areas
- Search Areas for Potential Habitat Expansion
- Connectivity Zone
- Linear Features

These elements need to be incorporated into spatial plans being developed by local authorities and other bodies.

There is an ever increasing evidence base to show the benefit and value of the ecosystem services (green infrastructure benefits) delivered from our green infrastructure across all areas of the socio-economic agenda, as shown in the evidence section below and in online knowledge portals such as that developed by the Forestry Commission[190].

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[190]Benefits of Green Infrastructure Knowledge Portal.
http://www.eforestry.gov.uk/forestdss/webpages/bgi/home.jsp

However, there is still a gap between this evidence base, the supportive policy environment, and wide range implementation. Whilst there are good examples of green infrastructure thinking being delivered in some projects, there are also a great number of missed opportunities.

The Mersey Forest Partnership's Forest Plan has provided a framework for the delivery of EWGS funding locally and a similar approach to the future rounds of EU Environmental Stewardship funding, overseen through the LNP and Merseyside Leader Group could help to join up activity and target resources at the key areas to help enhance biodiversity and deliver the range of services need from the ecological network.

The importance of key areas of the ecological network to the economic agenda provides a good opportunity to show how the Green Infrastructure and Ecological Framework can play a key role in delivering amongst others:

- The cleanest urban river in Europe - The River Mersey as part of the City Region Deal
- Tourism development - along Sefton and Wirral Coast and in the emerging Forest Parks
- The backdrop to Atlantic Gateway

In terms of biodiversity the Liverpool City Region did not achieve the Government target for 95% of SSSIs to be in favourable or recovering by 2010 (achieving 93.9%, 1.1% below the target).

In terms of funding for biodiversity and ecological framework improvements the EU Rural Development Programme has provided over £10m of funding between 2007 and 2012. The new Rural Development Programme is expected to continue to see an increase in resources targeted to environmental stewardship.

Key Questions

- What and where in the city region are the key elements of the ecological framework and how do they relate to the wider green infrastructure framework?
- How can green infrastructure planning help to safeguard and improve the provision of the ecosystem services that are critical for the city region[191]?
- How do we ensure green infrastructure actions lead to biodiversity benefits?
- How can the green infrastructure framework assist in reducing visitor pressure on sensitive international ecological sites?
- How can funding such as RDPE and EWGS, as well as Community Infrastructure Levy be better targeted to achieve biodiversity and ecological framework gains and meet local need?

Evidence overview

A study of four urban areas on Merseyside revealed that the greatest influence on their ecology was the proportion of green space, particularly trees[192]. The 10-35ha parks will contain all the birds recorded in any urban area of that region[193]. Species might have to move between various areas to reach the different resources they need, and the provision of street trees can provide alternative nesting sites and links between parks.

[191] This issue is in effect asking how all of the GI actions can be implemented.
[192] Whitford, V., Ennos, R., and Handley, J.F.. (2001) 'City form and natural process' – indicators for the ecological performance of urban areas and their application to Merseyside, UK, Landscape and Urban Planning, 57(2),): 91-103.
[193] Fernández-Juricic, E. and Jokimäki, J. (2001) A habitat island approach to conserving birds in urban landscapes: case studies from southern and northern Europe. Biodiversity and Conservation 10, 2023–2043.

Wildlife corridors are important in helping to overcome habitat fragmentation and to ensure that populations of key Species do not become isolated or die out due to inbreeding[194]. However, this "corridor" role is not a major consideration in the current work on an ecological framework for the city region, where the focus is on habitat expansion areas.

Green infrastructure in built-up areas is potentially a more hospitable environment for flora and fauna than intensively farmed agricultural land in rural areas[195]. In particular private gardens are of great importance for biodiversity in urban areas, as they contain a diverse range of habitats. Well-managed roundabouts and road verges support a wide variety of plants and insects, especially if they are not too intensively mown, not sprayed with herbicides, and have suitable trees planted on them.

Work by Landlife in Liverpool and on major roads leading to the city has highlighted that increasing biodiversity through developing wildflower areas along verges, can also add to the "quality of place" by improving the aesthetic value of an area.

Woodland Trust have specific campaigns that recognise the importance of Ancient Semi Natural Woodlands and Ancient Trees as key elements of our landscape and biodiversity[196].

Ecological value of urban habitats: Key factors influencing the value of green infrastructure for biodiversity are the area of habitat available, the type and diversity of green spaces, and proximity to other sites. A study of four urban areas on Merseyside revealed that the greatest influence on their ecology was the proportion of green space, particularly trees[197]. Sites where many species most commonly occur include city parks, cemeteries, rail tracks and previously developed land[198]. Sufficient amounts of green space of relevant ecological quality in urban landscapes may even allow the presence of specialist forest or endangered species[199,200]. Survey of 15 parks in highly urbanised Flanders, Belgium revealed that they contained 30% of wild plant species, 50% of breeding birds, 40% of butterflies, and 60% of the amphibians occurring in Flanders[201]. Generally, the larger the parks or other habitat patches, the higher the species richness[202]. The 10-35ha parks are likely to contain all the birds recorded in any urban area of a given region[203]. The diversity of land use types and adjacent green space in urban areas in the UK has been found to be crucial for supporting richness of bird[204] and butterfly species[205].

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194 O'Brien,E. (2006) Habitat fragmentation due to transport infrastructure: Practical considerations. Environmental pollution 10, 191-204.

195 Loram Loram, A., Thompson, K., Warren, P.H. and Gaston K.J. (2008) Urban domestic gardens XII: the richness and composition of the flora in five U.K. cities. Journal of Vegetation Science 19, 321-330

196 http://www.ancient-tree-hunt.org.uk/discoveries/interactivemap

197 Whitford, V,., Ennos AR, A.R. and Handley JF, J.F. (2001) 'City form and natural process' – indicators for the ecological performance of urban areas and their application to Merseyside, UK. Landscape and Urban Planning 57: 91-103.

198 Kendle, T & FORBES. and Forbes, S. (1997) Urban nature conservation. E&FN Spon, London.

199 Park, C-.-R &. and Lee WS, W.S. (2000) Relationship between species composition and area in breeding birds of urban woods in Seoul, Korea. Landscape and Urban Planning 51: 29-36.

200 Alvey AA, A.A. (2006) Promoting and preserving biodiversity in the urban forest. Urban Forestry and Urban Greening 5: 195-201.

201 CprnelisCornelis, J &. and Hermy, M. (2004) Biodiversity relationships in urban and suburban parks in Flanders. Landscape and Urban Planning 69: 385–401.

202 Davies, L,., Kwiatkowski, L,., Gaston KJ,, K.J., Beck, H,., Brett, H,., Batty, M,., Scholes, L,., Wade, R,., Sheate WR,, W.R., Sadler, J,., Perino, G,., Andrews, B,., Kontoleon, A,., Bateman, I &. and Harris JA, J.A. (2011) Urban In: The UK National Ecosystem Assessment Technical Report. UK National Ecosystem Assessment, UNEP-WCMC, Cambridge

203 Fernández-Juricic, E &. and Jokimäki, J. (2001) A habitat island approach to conserving birds in urban landscapes: case studies from southern and northern Europe. Biodiversity and Conservation 10: 2023–2043.

204 Young CH & JARVIS PJ, C.H. and Jarvis, P.J. (2001) Assessing the structural heterogeneity of urban areas: An example from the Black Country (UK). Urban Ecosystems 5: 49-69.

205 Hardy PB &, P.B. and Dennis RLH, R.L.H. (1999) The impact of urban development on butterflies within a city region. Biodiversity and Conservation 8: 1261-1279.

Planting trees and maintaining a well-balanced mix of vegetation in urban 'green spaces' can enhance the species diversity of birds and compensate for the negative effect of building[206].

Connectivity of habitats: Wildlife corridors are important in helping to overcome habitat fragmentation and to ensure that species can reach the different resources they need, and that populations of species do not become isolated or die out due to inbreeding[207]. Also, as the climate changes, the range of species may shift northwards and upwards to higher altitudes as they seek new „climate spaces". Their ability to do this is affected by the fragmentation of existing habitats and the permeability of the landscape between habitats. A study of butterflies migration in the North West suggests that features oriented north-south (such as grass verges along major roads) may aid species movement, whereas east-west features could act as barriers unless appropriately designed[208]. To help biodiversity move and survive in urban areas, change in the management of close-mown amenity grass and encouraging wildlife friendly gardening are needed.[209] Ecological networks are implemented in cities across the UK. In Birmingham, the management of wildlife in the city has relied heavily on corridors as strategic planning tools since development of the wildlife conservation strategy in 1997 explicitly built around the corridor concept. In London, the South East London Green Chain extends over 40 miles linking 300 open spaces, combining nature conservation and other benefits[210].

Gardens as an important biodiversity resource: Gardens cover around a quarter of the major urban areas in the UK[211], and 16.2%of Liverpool is covered by gardens. In London, out of the estimated 7 million trees, two thirds are located within domestic gardens.[212] The variation of management practices of gardens creates a diverse land mosaic, which supports higher number of species (plants, butterflies, birds, lizards) than the more urbanized areas or the managed countryside[213],[214],[215]. The biodiversity in gardens is also supported by the popularity of bird feeding and wildlife gardening practices: survey data from Sheffield estimated that 14.4% contained ponds, 26% had nest boxes, 29% had compost heaps and 48% had trees more than 3 m tall [216],[217]. By creating adjacent gardens in residential areas the largest semi-natural areas in cities can be formed [218], which can act as dispersal corridors for various species[219],[220] and

[206] Fontana, S., Sattler, T., Bontadina, F. & Moretti, M. (2011) How to manage the urban green to improve bird diversity and community structure. Landscape and Urban Planning. 101: 278-285.
[207] O'Brien, E. (2006) Habitat fragmentation due to transport infrastructure: Practical considerations. Environmental Pollution 10: 191-204.
[208] Gilchrist, A. (2011) Climate change, species range expansion and the institutional response. Unpublished PhD thesis, University of Manchester.
[209] Mitchell, R.J.,. Morecroft MD,, M.D., Acreman, M.,. Crick HQP,, H.Q.P., Frost, M.,. Harley, M.,. Maclean IDM,, I.D.M., Mountford, O.,. Piper, J.,. Pontier, H.,. Rehfisch MM,, M.M., Ross LC,, L.C., Smithers RJ,, R.J., Stott, A.,. Walmsley CA,, C.A., Watts, O &. and Wilson, E. (2007*) England Biodiversity Strategy - towards adapation to climate change.* DepartmentDEFRA, London. .
[210] See Davies et al (2011) Davies, L., Kwiatkowski, L., Gaston, K.J., Beck, H., Brett, H., Batty, M., Scholes, L., Wade, R., Sheate, W.R., Sadler, J., Perino, G., Andrews, B., Kontoleon, A., Bateman, I. and Harris, J.A. (2011) Urban In: The UK National Ecosystem Assessment Technical Report. UK National Ecosystem Assessment, UNEP-WCMC, Cambridge
[211] Loram A, Tratalos J, Warren PH & Gaston KJ (2007) Urban domestic gardens (X): the extent & structure of the resourcetheresource in five cities. L*andscape Ecology* 22*Ecology*22: 601–615.
[212] See Davies et al. (2011).
[213] Blair RB &, R.B. and Launer AE, A.E. (1997) Butterfly diversity and human land use: Species assemblages along urban gradient. Biological Conservation 80: 113-125.
[214] Sandstrom UG,, U.G., Angelstam, P &. and Mikusinski, G. (2006) Ecological diversity of birds in relation to relationto the structure of urban green space. Landscape and Urban Planning 77: 39-53.
[215] See Davies et al. (2011).
[216] Gaston KJ,, K.J., Warren PH,, P.H., Thompson, K &. And Smith RM, R.M. (2005) Urban domestic gardens (IV): the extent of the resource and resource and its associated features. *Biodiversity and Conservation* 14: 3327–3349.
[217] Gaston KJ,, K.J., Fuller RA,, R.A., Loram, A,., MacDonald, C, ., Power, S &. and Dempsey, N. (2007) Urban domestic gardens (XI): Variation in urban wildlife gardening in the UK. *Biodiversity and Conservation* 16*andConservation*16: 3227–3238.
[218] Rudd, H.,. Vala, J & . and Schaefer, V. (2002) Importance of backyard habitat in a comprehensive biodiversity comprehensive biodiversity conservation strategy: a connectivity analysis of urban green space. Restoration Ecology 10Ecology10: 368-375.

individual gardens can be 'stepping stones' allowing dispersal to other sites, e.g. for insects with limited ability of flight. However, the area of gardens in cities is shrinking as a result of infill and paving: 13% of gardens were lost in a residential area of Leeds over the last 33 years[221] and 5% of vegetated areas got developed in Merseyside between 1975 and 2000[222].

Biodiversity by Design[223] sets out a range of opportunities to incorporate biodiversity into new development, as part of high quality design. The guide encourages:

- Integrating existing and new elements into large scale planning
- Revising park management to include structurally diverse vegetation[224]
- Using the distinct flora of the area as a 'pattern book'
- Managing linear features to minimise disturbance and consider woodland or wetland linkages
- Planting native species wherever the situation makes them an appropriate choice
- Using higher plot ratios (more people per m_2 of plot) if the aim is to increase opportunities for a continuous mosaic of doorstep habitats
- Requiring developers to creatively incorporate habitats into buildings and communal spaces, e.g. through green roofs, climbing plants, and artificial bat and bird nest sites.

James, Norman and Clarke[225]in a study of bird population change in Warrington and Halton over the last 20 years highlighted the role that (GI) planning and management can play in improving avian biodiversity noted that,

"Now that aerial or aquatic pollution appears to present little constraint on breeding bird species in Halton and Warrington, habitat structure and area will probably be the most important factors in promoting further increases in avian diversity, and should be the focus of future urban planning and site management."

Research by Fuller et al[226]found that there was a positive association between areas of green space with a high degree of habitat heterogeneity and species diversity and the wellbeing of people visiting these areas highlighting the link between biodiversity and mental health, another of the city region GI Framework priorities.

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219 Szacki, J,., Glowacka, I,., Liro, A &. and Matuszkiewicz, A. (1994) The role of connectivity in the urban landscape: Some results of research. Memorabilia Zoologica 49, 49-56.

220 Bolger DT,, D.T., Scott TA &, T.A. and Rottenberry JT, J.T. (2001) Use of corridor-like landscape structures by bird and small mammal species. Biological Conservation 102: 213-224.

221 Perry, T &. and Nawaz, R. (2008) An investigation into the extent and impacts of hard surfacing of domestic gardens in an area of Leeds, United Kingdom, *Landscape and Urban Planning* 86: 1–13.

222 Pauleit, S,., Ennos, R &. and 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.

223 TCPA (2004) Biodiversity by Design. Available at: www.tcpa.org.uk/pages/biodiversity-by-design.html

224 It has been suggested that one of the most useful corridors for wildlife movement could be achieved by changing the mowing regime in public parks – though this has to be balanced with a range of other issues related to park use and image.

225 http://www.cawos.org/James%20Norman%20Clarke%20Urban%20Ecosystems.pdf James, P., Norman, D. and Clarke, J.J. (2010) Avian population dynamics and human induced change in an urban environment. Urban Ecosystems 13: 499-515.

226 Fuller R.A., Irvine K.N., Devine-Wright, P., Warren, P.H. and Gaston, K.J.(2007,) Psychological benefits of greenspace increase with biodiversity; Biol Lett (2007),. Biology Letters 3(4): 390-394.

Health and wellbeing

Issues

The city region faces a range of health challenges including

- High Levels of poor mental health
- High Levels of coronary heart disease (CHD)
- High Levels of air pollution leading to both bronchial and pulmonary disease, and CHD. A recent report identified air pollution as one of the major causes of heart attacks.
- Health inequalities
- Increasing levels of obesity, including childhood obesity.
- A clinical need for more post treatment exercise to counter the long term effects of treatments such as chemotherapy.

There are also a wide range of structural changes impacting on the way in which the health service is commissioned, delivered and managed.

Finances for the health sector are restricted and under pressure due to the increasing burden of poor health due to lifestyle and demographics.

Whilst the dominant health paradigm is a clinical one, public health in some places is being seen as having an important role to play in reducing the burden of ill health on the health service and more widely on society.

The “Five Ways to Wellbeing” is being championed in the city region as a framework to improve wellbeing.

Green infrastructure planning can contribute to improving all of these issues, but only in collaboration with the health authorities and by recognising GI’s role amongst the full range of determinants of health and wellbeing.

Key Questions

- What and where are the key health and wellbeing issues in the sub region that green infrastructure can assist in resolving?
    - Obesity
    - CHD
    - Air quality
    - Mental health
    - Inequalities in health
    - Post-operative/treatment recovery

- How can green infrastructure play a role in supporting the 5 Ways to Health and Wellbeing across the city region?

- How can green infrastructure be properly considered as part of the new arrangements for health service commissioning and help "encourage coherent commissioning strategies"?

Evidence

General health and wellbeing

There is an extensive body of evidence to support green infrastructure interventions as a way of helping to improve health and wellbeing.

The evidence points to five main areas of health benefit that can be achieved through green infrastructure planning, management and delivery.

- Increased physical activity
- Improving air and land quality
- Improving mental health
- Reducing health inequalities
- Social cohesion
- Increasing physical activity

Research by Sport England[227]estimates that the cost of poor health due to lack of exercise could be as high as £2bn per year to the national economy. The same report estimates that a 10% reduction in those aged 16+ who are sedentary would benefit the economy by £500 million a year in reduced NHS costs, and increased economic output due to lower ill health and absence from work.

Data from the 'National Travel Survey' show that the distance people walk and cycle has declined significantly in the last three decades[228].

Various epidemiological studies have demonstrated a positive relationship between green space and population health[229]. For example, a study in the UK[230] found 'A higher proportion of green space in an area was generally associated with better population health.'

A recent Natural England study[231] showed that:

- People who live furthest from public parks were 27% more likely to be overweight or obese.
- Children able to play in natural green space gained 2.5 kg less per year than children who did not have such opportunities.
- 1,300 extra deaths occur each year in the UK amongst lower income groups in areas where the provision of green space is poor.

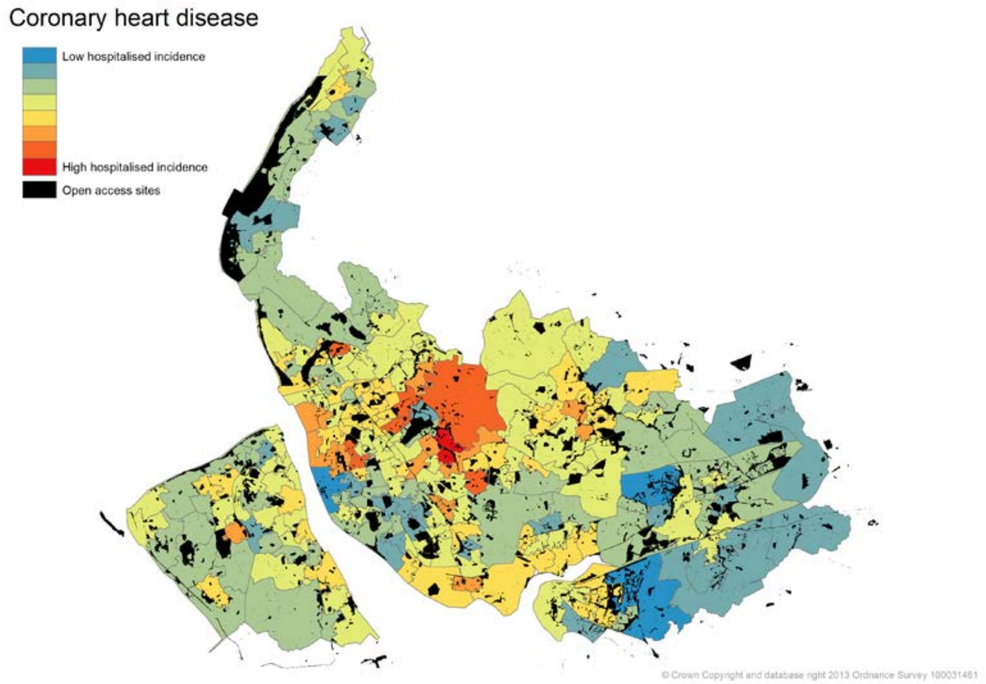
NICE guidance[232,233] contains extensive evidence to support their policy recommendations. This is an important evidence base as it is used as the basis for guidance to the health service. It suggests that increasing physical activity can help to prevent or manage over 20 conditions and diseases including coronary heart disease, diabetes and obesity. The guidance also emphasises the importance of having environments that encourage healthy lifestyles, creating opportunities to walk or cycle easily and in safety. Increasing physical activity levels in the population will help prevent or manage coronary heart disease[234].

227 Sport England (2002) A Strategy for Delivering Sport and physical Activity Cabinet Office (2002) Game Plan: A strategy for delivering government's sport and physical activity objectives. Available at: http://www.gamesmonitor.org.uk/files/game_plan_report.pdf .
228 Department for Transport (2006) National travel survey Travel Survey 2006
229 Mitchell, R. And Popham, F. (2007) Greenspace, urbanity and health: relationships in England. Journal of Epidemiology and Community Health 61: 681-683.
230 See Mitchell and Popham (2007)
231 Natural England (2009) Green Space Access, Green Space Use, physical activity and overweight: a research summary. Based on original research for Natural England by University of Bristol and University of East Anglia.
232 NICE (2008) Public Heath guidance Guidance 8: Promoting and creating built or natural environments that encourage and support physical activity. National Institute for health and Clinical Excellence, London.
233 NICE (2009) Public Health guidance Guidance 17: Promoting physical activity, active play and sport for pre-school and school-age children and young people in family, pre-school, school and community settings. National Institute for health and Clinical Excellence, London.
234 Department of Health (2005) Choosing activity: a physical activity action plan. Department of Health, London.

Providing opportunities across the city region for participation in food and other growing projects offers an opportunity to increase physical activity, increase social interaction and also increase consumption of fresh fruit and vegetables[235].

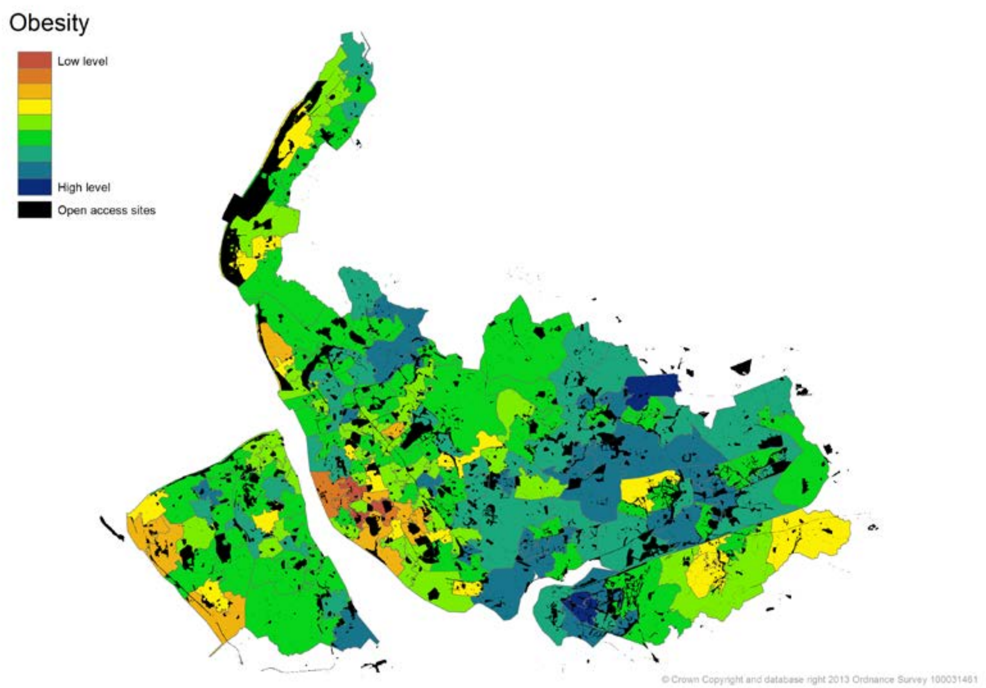
Comment [AK3]: I have not found this publication.

Map 5 Coronary heart disease



235 SQW (2010) Greening the City, Liverpool City Council

Map 6 Obesity



Improving air quality and reducing noise pollution

Air pollution has been found to increase the risk of having a second heart attack among cardiac patients by 43%[236]. An increase in air pollution has also been identified to increase the short-term risk of stroke[237].

Trees and woodlands are particularly effective at removing some elements of pollution from the atmosphere. Work by Lancaster University identified ozone, nitrogen dioxide and PM10 particles as being the main pollutants that can be removed. The study estimates that doubling the number of trees in the West Midlands would reduce excess deaths due to particulate pollution by up to 140 per year[238].A US study reported in the British Medical Journal concluded that childhood asthma was lower in areas with higher levels of tree cover[239].

The Woodland Trust report on the positive impact of trees on urban air quality includes recommendations for the best types of tree to plant to help reduce air pollution[240].

236 American Friends of Tel Aviv University (2012, June 5). Air pollution linked to chronic heart disease. *Science Daily*. Available at: http://www.sciencedaily.com/releases/2012/06/120605121700.htm

237 Wellenius, G.A., Burger, M.D., Coull, B.A., Schwartz, J., Suh, H.H., Koutrakis, P., Schlaug, G., Gold, D.R., Mittleman, M.A. (2012). Ambient air pollution and the risk of acute ischemic stroke. Archives of Internal Medicine 172(3): 229-234.

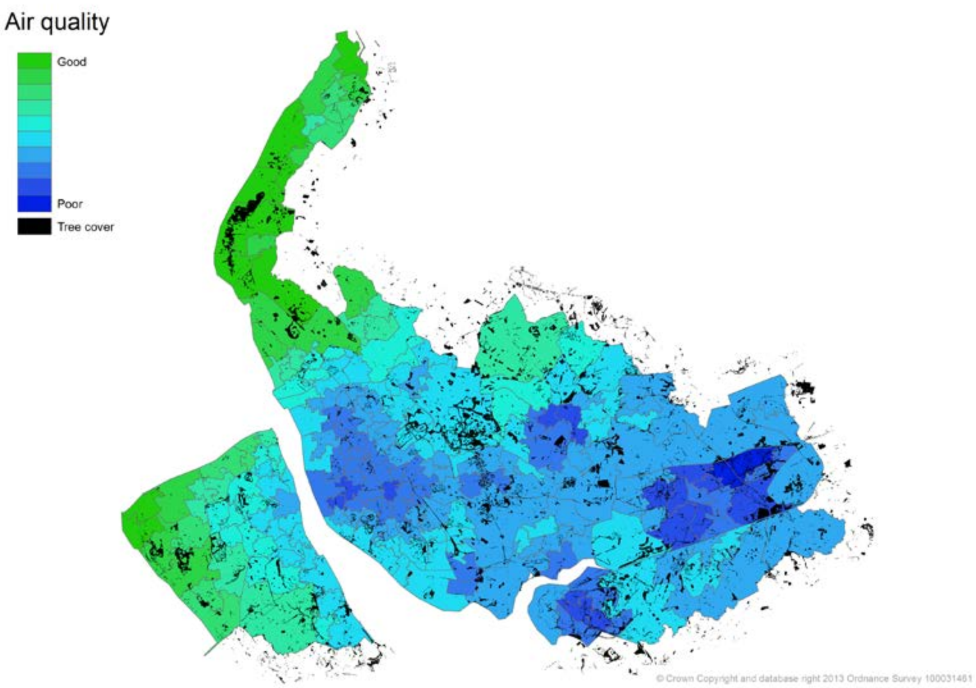
238 http://www.es.lancs.ac.uk/people/cnh/docs/UrbanTrees.htm CEH (no date) Trees and sustainable urban air quality. Available at: http://www.es.lancs.ac.uk/people/cnh/UrbanTreesBrochure.pdf

239 Schellenbaum Lovasi GS, G. Quinn, J.W., Neckerman, K.M., Perzanowski, M.S. and Rundle, A. (2008) Children Livingliving in areas with more street trees have a lower prevalence of asthma, J EpidemiolJournal of Epidemiology and Community Health 62:647–649.

240http://www.woodlandtrust.org.uk/en/campaigning/ourcampaigns/Documents/urbanairqualityreport.pdf

Noise can be an issue that can lead to additional stress and poor health. Trees and other vegetation can play an important role in attenuating noise through reflecting and absorbing sound energy. One estimate suggests that seven decibel noise reduction is achieved for every 33m width of forest[241] whilst other reported field tests show apparent loudness reduced by 50% by wide belts of trees and soft ground[242].

Map 7 Air quality



Improving mental health

Mental health problems are increasing: one in six adults have mental health problems at any one time, for half these people the problem will last for more than a year, and it is estimated that around one in four people will suffer some form of mental illness at some point in their lives[243]. Mental health problems are estimated to cost the economy £23 billion[244] a year in lost output.

It has been suggested that 'mental illness causes as much of the misery in Britain today as poverty does. "It is our greatest hidden problem"[245].

[241] Coder, R.D. (1996) Identified Benefits of Community Trees and Forests, University of Georgia Cooperative Extension Service - Forest Resources Publication FOR96-39

[242] Dwyer , J.F., McPherson, E.G., Schroeder, H.W. and Rowntree, R.A. (1992) Assessing the benefits and Costs of the urban forest. Journal of Arboriculture 18(5),): 227 – 234.

[243] Department of Health (2009) The Future Vision Coalition. Available at: http://www.newvisionformentalhealth.org.uk/about.html

[244] The Sainsbury Centre for Mental Health (2003) Policy Paper 3: The Economic and Social Costs of Mental Illness. Available at: http://www.centreformentalhealth.org.uk/pdfs/costs_of_mental_illness_policy_paper_3.pdf

[245] Layard 2007 - Layard, R., Clark, D., Knapp, M.,. And Mayraz, G. ((2007) CEP Discussion Paper No 829. Cost-Benefit Analysis of Psychological Therapy. Centre for Economic Performance, London School of Economics, London. Available at: http://eprints.lse.ac.uk/19673/1/Cost-Benefit_Analysis_of_Psychological_Therapy.pdf).

Whilst there is good evidence to show that green infrastructure can help to support more active lifestyles, the evidence for positive impact on mental health problems is even stronger[246].

There is evidence that green spaces can have a positive effect on mental well-being and cognitive function through both physical access and usage[247], as well as through access to views of the natural environment[248]. Work by Ulrich in the US has been influential in hospital design, with a number of hospitals around the world (including Alder Hey in Liverpool) ensuring that wards have views of the natural environment. The aim is to both improve rates of recovery and quality of life of patients as well as reducing time spent in hospital, releasing more beds and improving the "productivity" of the hospital.

There is evidence that even the visual presence of green spaces and natural views of elements such as trees and lakes is enough to have a positive effect on stress levels, can promote a reduction in blood pressure and may encourage faster healing in patients following post-surgical intervention[249].

Wilson's 'biophillia hypothesis'[250] seeks to explain the calming and mood enhancing effect of certain green spaces in terms of our evolutionary history. He suggests that our general preference for green environments is "hard wired", that it comes about because we are genetically predisposed to such environments. Pretty[251], suggests in a similar vein that humans have evolved through 350,000 generations in contact with nature, our disconnection from nature over the last 200 years (since the industrial revolution) is a short time span to evolve in response to the new way in which we live, we therefore still tend to seek greener areas and feel better in such areas.

Direct evidence of the restorative effects of green space and mental health has been found in several studies. Two studies looking at children aged 7-12 found that green space can have a beneficial impact on concentration and on the ability to focus attention.[252]

There is evidence that there are synergistic effects of exercise in "green" environments that improves the positive impact on both physical and mental health.[253]

[246] O'Brien et al. O'Brien, L., Williams, K. and Stewart, A. (2010) Urban health and health inequalities and the role of urban forestry in Britain: a review. Report to the Forestry Commission. Available at: http://www.forestresearch.gov.uk/fr/INFD-83EHVX

[247] Whitelaw et al. (2008) Physical activity and mental health: the role of physical activity in promoting mental wellbeing and preventing mental health problems: An evidence briefing. NHS Scotland, Edinburgh.

[248] Ulrich, R.S. (1984) View through a window may influence recovery from surgery. Science 224,: 420–421.

[249] DEFRA Forest Research (2010) Benefits of Green Infrastructure. Report by Forest Research. Forest Research, Farnham.

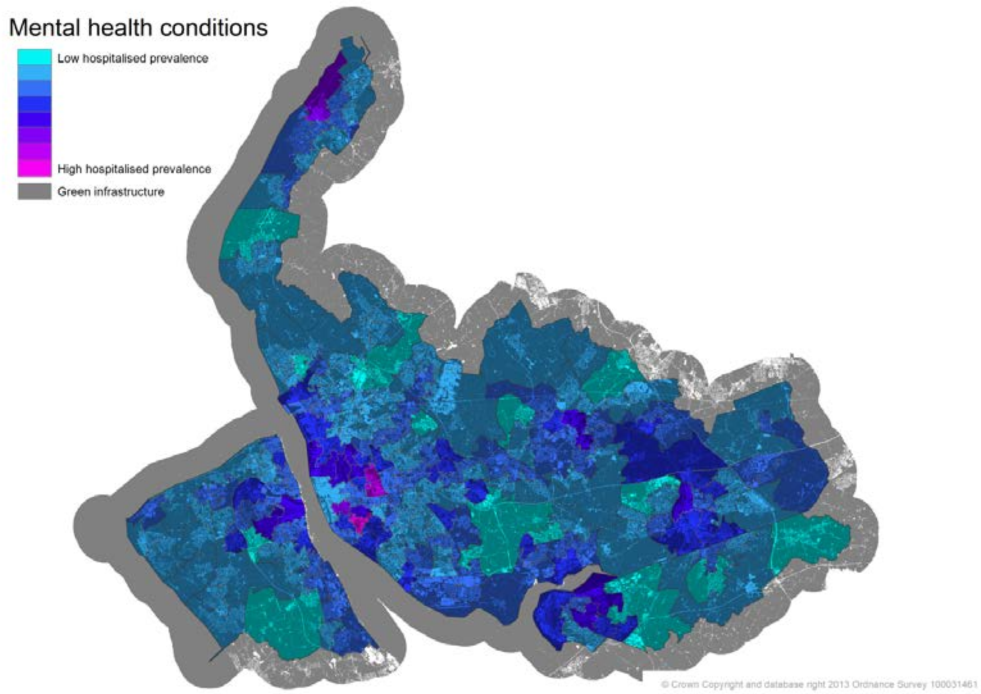
[250] Wilson (1984) Biophilia: The human bond with other species. Harvard University press, Cambridge, Massachusetts.

[251] Pretty (2009) Agriculture, Reconnecting people, land and nature. Earthscan, London.

[252] Forest Research (2010) Benefits of Green Infrastructure. Report by Forest Research. Forest Research, Farnham.

[253] Pretty, J., Griffin, M., Sellens, M. And pretty, C. (2003) Green Exercise: Complementary Roles of Nature, Exercise and Diet in physical and Emotional Wellbeing and implications for Public Health Policy. CES occasional Paper 2003-1, University of Essex.

Map 8 Mental health



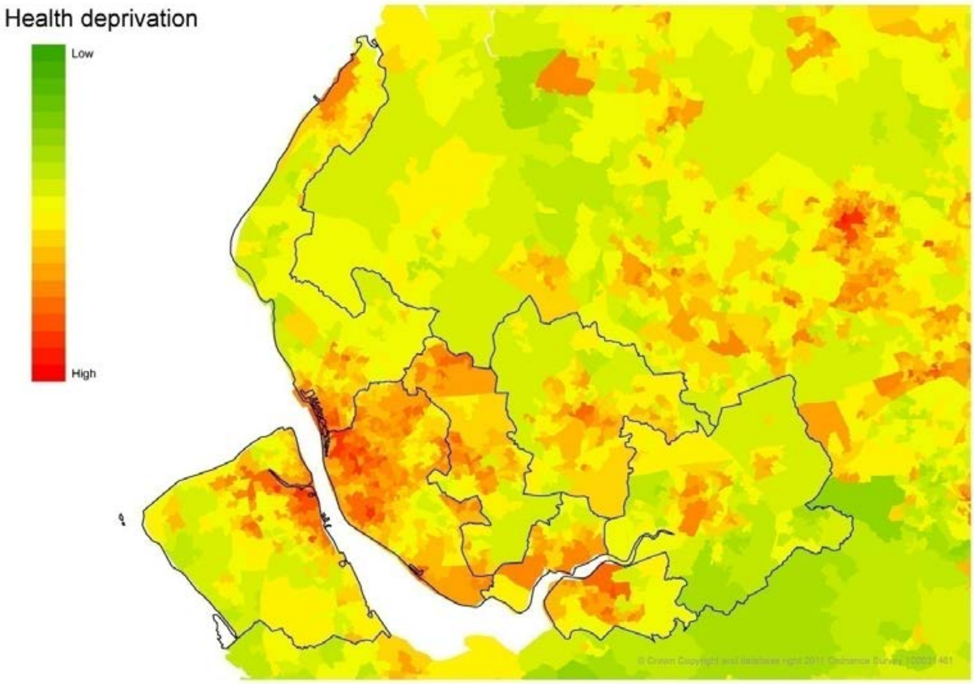
Reducing health inequalities

Recent research at Glasgow University found that:

“Populations exposed to greener environments also enjoy lower levels of income deprivation related health inequality. Physical environments which promote good health may be important in the fight to reduce socio-economic health inequalities.”[254]

[254] Mitchell &, R. and Popham, F. (2008) Effect of exposure to natural environment on health inequalities: an observational population study. The Lancet 372(9650): 1655-1660.

Map 9 Health deprivation - indicates the range and spatial distribution of health deprivation across the city region and Warrington



Social cohesion

There are a range of studies that show that using green space leads to greater social contact and community cohesion. Physical and mental health initiatives utilising green space have been shown to have additional social well-being benefits, for example involvement in "Friends of" groups. Green space can also lead to more day to day experience of greater neighbourliness as people meet in allotments community gardens or simply chat over the garden fence[255]. A recent PhD found that in the inner-city areas of Greater Manchester, the duration of visits to local parks was associated with the number of people the local residents recognised in the area. Also, the longer the visits were, the more friends people had in the area. This suggests that parks may promote social contacts between people and create social ties[256].

It has also been shown that greener neighbourhoods create stronger social ties and that there were lower instances of reported crime and domestic violence. Such impacts are more likely if the quality of the green space is high and carefully designed projects are initiated.[257]

A study of inner city children in Chicago found that there were significantly higher levels of creative play when the children played in the green spaces around their apartment blocks rather

[255] CABE (2007) The Value of Public Space. Commission for Architecture and the Built Environment, London.
[256] Kazmierczak A (in press) The contribution of local parks to neighbourhood social ties. Landscape and Urban Planning, http://dx.doi.org/10.1016/j.landurbplan.2012.05.007.
[257] Forest Research (2010) Benefits of Green Infrastructure. Report by Forest Research. Forest Research, Farnham.

than in the barren areas. Children playing in the green spaces also had more opportunity to be with adults, a factor that can aid the development of interpersonal skills.[258]

More recent work based on Forest Schools[259] in Sefton has shown that not only did the learning in the natural environment lead to greater levels of physical activity by children involved in the programme, but also that the children involved encouraged parents and siblings to be more active too.

[258] InfrastructureSee Forest Research (2010)
[259] Ridger &, N.D. and Sayers, J. (2010) Natural Play in the Forest: A Pilot Evaluation of a Forest School Evaluation. Available at: http://www.forestry.gov.uk/pdf/trees_and_society_Apr2010_Sayers.pdf/$FILE/trees_and_society_Apr2010_Sayers.pdf

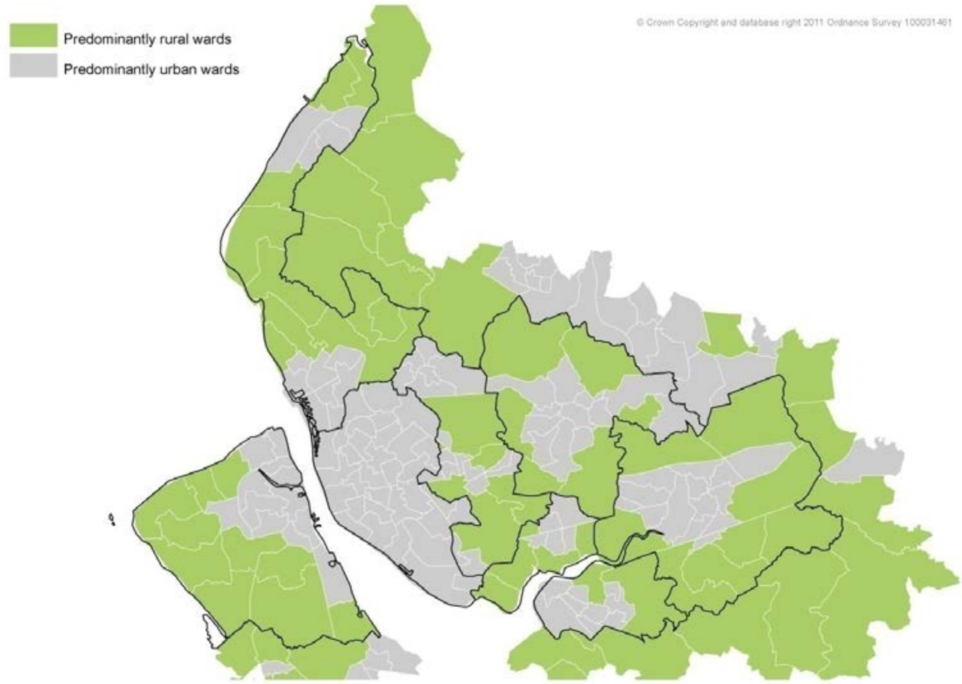
Rural Economy

Issues

The rural economy of Liverpool City region has been quietly successful and is an important part of the city region's economy. In Warrington, despite having a large rural area if anything it has achieved and even lower profile that in Liverpool City Region.

Unlike the other five priorities, the rural economy is in a defined place within the city region and Warrington. This is helpful in targeting action and identifying specific issues, but reinforces one of the problems, that the rural areas (and economy) are not fully integrated into the "main" strategic economic thinking for the city region and Warrington.

Map 10 Rural Areas of the City Region and Warrington



Increasing access to local markets can help to reduce costs and CO_2emissions and also increase resilience of the economy to global changes in commodity price.

Whilst the city region has successfully develop the ICEP and Leader programmes Warrington has missed out on equivalent funding.

The rural areas cover a significant area of the city region and Warrington's greenbelt which is coming under pressure for development with some areas likely to be released in the coming years.

The rural economy needs to find a strong advocate to enable its past success to be sustained. The new programme of RDPE post 2015 may enable continued business development and training for an agricultural industry with an ageing workforce.

Land use and land use change is a major contributor to greenhouse gas emissions contributing to climate change as described in the climate change section above. Improvements to management practice and land use can help to deliver a low carbon economy.

Increasing links between the rural and urban areas both physically and economically will have benefits for the city region and Warrington

Key Questions

- Who can act as the strategic advocate for the rural economy?
- What are the key actions to take forward from the Merseyside Rural Economic Assessment?
- What opportunities exist to contribute to the reduction of carbon emissions and storage of carbon?
- How can green infrastructure help secure achieve targets of EU funding through the new RDPE?
- How do we maximise the use of local food and timber products?
- How can support for rural areas through programmes such as ERDF, Leader and Axis 1, 2 and 3 of RDPE to be coordinated better to deliver a wider range of objectives e.g. Water Framework Directive
- Where are the key sub-regional areas for natural tourism?
    - Forest parks
    - Local Nature Reserves
- How can rural areas help to tackle "pinch points"? How is this resourced? (PES section in funding?)

Evidence

The rural economy of the Liverpool City Region is often overlooked. However it constitutes 58% of the land area, contributes 22% of GVA and provides the raw materials for many of the urban based businesses. The Merseyside Rural Economy Action Plan and Mersey Rural Leader provide much of the information on the issues that impact on this area. There is less information available for the Warrington area.

The rural sector and the organisations have successfully delivered a number of EU funded development programmes that have enabled businesses to develop and to improve productivity.

Whilst several strands of support are targeted at the area, they are not always well coordinated and opportunities to deliver key strategic objectives are sometimes missed such as opportunities to improve tourism and tackle issues related to water quality and flooding.

There are opportunities to develop greater linkage and coordination between urban and rural areas, with particular emphasis on local procurement and the development of recreation and tourism.
Rural areas provide much of the green infrastructure functionality in the city region, important for many of the benefits that we wish to safeguard. In addition, through appropriate changes to land management and support to enable that to happen it is possible that rural areas can also help to

tackle "pinch points" by providing functionality "upstream" of the problem area - reinforcing the link and dependency between these areas.

Increasing the productivity of land: One of the major risks of intensification of farming is the further decline in the quality of ecosystem services.[260] Green infrastructure can increase the long-term productivity of the countryside by supporting a higher diversity of species, for example pollinators, and by being an essential element of environmentally sensitive farming practices. The value of crops pollinated by honey bees in England is approximately £117 million.[261] The bees numbers have been declining in the recent years and green infrastructure can secure presence and diversity of flowering plants in the landscape, linked to the number of insects available for the pollination of agricultural crops.[262,263] Agri-environment schemes and organic farming tend to maintain system stability better than conventional farming, in longer term leading to improved soil quality, fertility and reduced soil erosion.[264,265] Introducing green infrastructure such as trees, vegetated field margins and hedgerows can not only increase biodiversity,[266] but may also help to maintain the productivity of land under the changing climate. For example, an experiment in the New Forest found that river shading from new trees maintained temperatures sufficiently cool for brown trout to survive.[267]

Promoting natural tourism: The natural tourism is an economically feasible alternative to agriculture in rural areas. Annually**,** visits by UK residents to the countryside and to the seaside already contribute, respectively, £5.5 billion and £7.4 billion for the English economy.[268] Visits to the countryside in 1998 generated 340,000 full time jobs;[269] walking in the English countryside alone supports between 180,000-245,000 full time jobs.[270]People are attracted to the countryside being 'the patchwork quilt of fields, woods, hedgerows and winding streams',[271] thus ensuring diversity in the landscape through green infrastructure could bring more tourists into the countryside. Woodlands and wildlife sites are important for tourism: visitors to an average forest site in England spent between £54,000 and £72,000 per year, amounting to £2.1 billion per year.[272] Forest-related tourism expenditures represent about 3.4% of total tourism spending[273]. RSPB reserves in the UK support over 1,000 full time jobs, and because they tend to be on less favourable agricultural land, tend to lead to an increase in economic activity when

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260 Foresight (2011) The Future of Food and Farming: Challenges and choices for global sustainability. Government Office for Science, London.
261 ADAS (2001.) An Economic Evaluation of DEFRA's Bee Health Programme. DEFRA. London.
262 Potts SG,, S.G., Biesmeijer JC,, J.C., Kremen, C,., Neumann, P,., Schweiger, O &. and Kunin WE, W.E. (2010) Global pollinator declines: trends, impacts and drivers. Trends in Ecology & Evolution 25: 345-353.
263 Carvell, C,., Roy DB,, D.B., Smart SM,, S.M., Pywell RF,, R.F., Preston CD &, C.D. and Goulson, D. (2006) Declines in forage availability for bumblebees at a national scale. Biological conservationConservation 132: 481-489.
264 Reganold JP,, J.P., Eliott LF &, L.F. and Unger YL, Y.L. (1987) Long-term effects of organic and conventional farming on soil erosion. Nature 330: 370-372.
265 Mäder, P,., Fliessbach, A,., Dubois, D,., Gunst, L,., Fried, P &. and Niggli, U. (2002) Soil fertility and biodiversity in organic farming. Science 296: 1694.
266 Vickery JA,, J.A., Bradbury RB,, R.B., Henderson IG,, I.G., Eaton MA &, M.A. and Grice PV, P.V. (2004) The role of agri-environment schemes and farm management practices in reversing the decline of farmland birds in England. Biological Conservation 119: 19–39.
267 Nisbet, T,., Silgram, M,., Shah, N,., Morrow, K &. and Broadmeadow, S. (2011) Woodland for Water: Woodland measures for meeting Water Framework Directive objectives. Forest Research Monograph, 4, Forest Research, Surrey.
268 Deloitte & Oxford Economics (2010) The Economic Contribution of the Visitor Economy: UK and the Nations. Visit Britain.
269 The Countryside Agency (1998) The economic impact of recreation and tourism in the English Countryside 1998. Wetherby.
270 Christie, M &. and Mathews, J. (2003) The economic and social value of walking in England. Ramblers.
271 Park JJ , J.J. and Selman, P. (2011) Attitudes towards rural landscape change in England. Environment and Behavior 43: 182-206.
272 Hill, G,., Courtney, P,., Burton, R &. and Potts, J. (2003) Forests' role in Tourism: Phase 2. Summary report - Final for the Forestry Group (Economics & Statistics) of the Forestry Commission.
273 Hill et al. (2003) Hill, G., Courtney, P., Burton, R. and Potts, J. (2003) Forests' role in Tourism: Phase 2. Summary report - Final for the Forestry Group (Economics & Statistics) of the Forestry Commission.

acquired[274]; people visiting just Osprey watching sites in the UK bring total additional expenditure of £3.5 million per year to the areas around the sites.[275]

Reducing the cost of water and flood management: Intensification of farming resulted in loss of hedgerows, overgrazing, channelized rivers, and compacted soils (due to winter crops), which has had a negative impact on the rate of infiltration.[276] Introducing green infrastructure measures such as grass buffers, temporary ponds, appropriate ditching and decanalisation can help to reverse this trend.[277] Wetlands also play a role in aquifer recharge[278].Woodlands contribute to tackling diffuse pollution through acting as a barrier and intercepting pollutants before they reach water courses. They help to trap and retain nutrients and sediment in polluted runoff[279]. A modelling study for the Yorkshire Derwent catchment shows that converting a fifth of arable land into extensive grassland results in 20% reduction in nitrate leaching.[280]

Production of biofuels: Changes in land use to achieve climate change mitigation are controversial from the landscape protection perspective. Also, to meet just one-third of the government's 2010 target on biofuels would require 1.2 million hectares of short rotation coppice and Miscanthus (equivalent of 20% of the UK's arable land). To achieve 5% of the country's energy from biofuels would require1.2-1.9 million hectares of additional wheat and oilseed rape. Nonetheless, bioenergy including woodfuel has the potential to fill a short-term energy gap.[281]

[274] Shiel, A,., Raymont, M &. and Burton, G. (2002) RSPB reserves and local economies. RSPB. Sandy.
[275] Dickie, I,., Hughes, J &. and Aniol, E. (2006) Watched Like Never Before… the local economic benefits of spectacular bird species. RSPB.
[276] O'Connell PE,, P.E., Beven KJ,, K.J., Carney JN,, J.N., Clements RO,, R.O., Ewen, J,., Fowler, H,., Harris GL,, G.L., Hollis, J,., Morris, J,., O'Donell GM,, G.M., Packman JC,, J.C., Parkin, A,., Quinn PF,, P.F., Rose SC,, S.C., Shepherd, M &. and Tellier, S. (2005) Review of impacts of rural land use and management on flood generation Impact study report. DEFRA, London.
[277] See O'Connell et al. (2005)
[278] World Resources Institute (2008) Ecosystems and Human Well-being: Wetlands and Water. Encyclopedia of Earth website.
[279] Nisbet et al. (2011) Nisbet, T., Silgram, M., Shah, N., Morrow, K. and Broadmeadow, S. (2011) Woodland for Water: Woodland measures for meeting Water Framework Directive objectives. Forest Research Monograph, 4, Forest Research, Surrey.
[280] Hutchins, M,., Fezzi, C,., Bateman, I,., Posen, P,., Deflandre-Vlandas, A. (2009) Cost-effective mitigation of diffuse pollution: setting criteria for river basin management at multiple locations. Environmental managementManagement 44: 256-267.
[281] Land Use Consultants (2007) Bioenergy: Environmental Impact and Best Practice. Report prepared for Wildlife and Countryside Link.

Summary

In this section we have looked at each of the 6 priority areas, assessed the issues that we think relate to GI, attempted to set out a series of key questions that the GI Framework should attempt to answer and back that up with a summary of the evidence base to support GI and GI Planning as ways and means of addressing the issues/questions.

The next Section covers steps 2-4 of the GI Planning process, creating, compiling and analysing data to enable us to get a full picture of GI in the region for the first time and be in a better position to answer the questions posed above.

Steps 2-4 Data and analysis

The full methodology for the assessment of steps 2-4 is set out in Appendix 1.

Table 9 shows the estimated typologies that have been identified across the city region. This provides, for the first time, a holistic view of green infrastructure types and the basis for identifying functionality and benefits.

We have used the term "estimated" to reflect the fact that we have not visited every piece of green infrastructure in the city region and have used the extensive array of existing data sets and where necessary professional judgement to identify and assign types.

We have assessed this methodology against aerial photography analysis of green infrastructure types and found a satisfactory correlation between the results (need to add data on this assessment)

Table 9 City Region Green Infrastructure Typology

Typology	Area (km^2)	% coverage of the city region
Agricultural land	229.66	21.13%
Allotment, community garden or urban farm	3.56	0.33%
Cemetery, churchyard or burial ground	3.64	0.33%
Coastal habitat	126.54	11.64%
Derelict land	3.72	0.34%
General amenity space	37.42	3.44%
Grassland, heathland, moorland or scrubland	115.37	10.62%
Green roof	0.00	0.00%
Institutional grounds	17.44	1.60%
Not green infrastructure	227.37	20.92%
Orchard	0.18	0.02%
Outdoor sports facility	58.60	5.39%
Park or public garden	18.14	1.67%
Private domestic garden	128.13	11.79%
Street trees (we need to comment or amend)	1.10	0.10%
Water body	7.80	0.72%
Water course	40.69	3.74%
Wetland	10.10	0.93%
Woodland	57.27	5.27%

Comment [s4]: This is actually the %age of all GI covered by each type; rather than the %age of the city region covered by each type. Be casreful with the wording here, and in text below.

We can see that

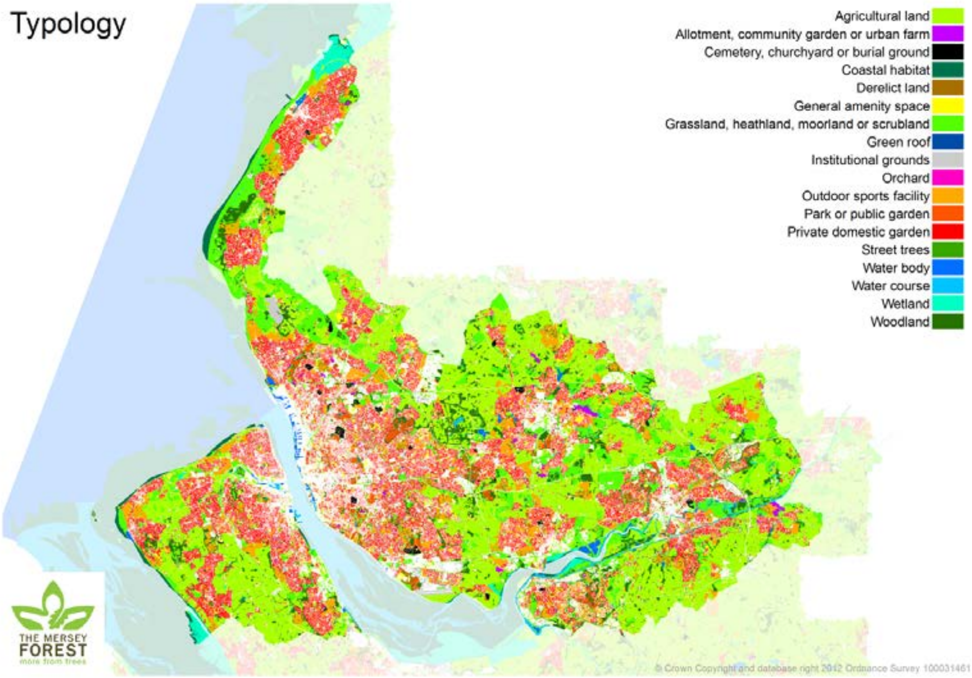
- The city region area covers 1090 sq km or just over 1 million hectares
- 79% of the city region is green infrastructure
- The three largest components are agricultural land (21%), private domestic gardens (12%) and coastal habitats (12%)

- Grassland, heathland, moorland or scrub also comes out as a major typology. This is predominantly grassland and there may be some areas which should be identified as "agriculture". Further analysis may result in the agricultural typology being increased
- The derelict land typology is very low (0.34%). However this is a consequence of how derelict land is identified and should not be confused with the official definition of dereliction. Derelict land will be subsumed either within the non-green infrastructure typology or one of the regenerating green infrastructure typologies such as grassland or woodland.
- Woodland cover at 5.27% is below the national average (8.4%). However this disguises the scale of woodland cover increase within the city region over the past fifteen years with over 15 million new trees planted

Comment [s5]: This is not the woodland cover, it is the % of GI that is woodland

Comment [s6]: England cover is 10%

Map 11 shows the spatial distribution of these green infrastructure types across the city region.



Map 11 Green Infrastructure Typology of Liverpool City Region with strong green corridors, mainly consisting of agricultural land running West- East. The corridors running north south are much more varied in their typology. It also shows the lack of GI concentrations on the landward side of The Mersey, and the importance of private gardens in the overall GI mosaic for the city region.

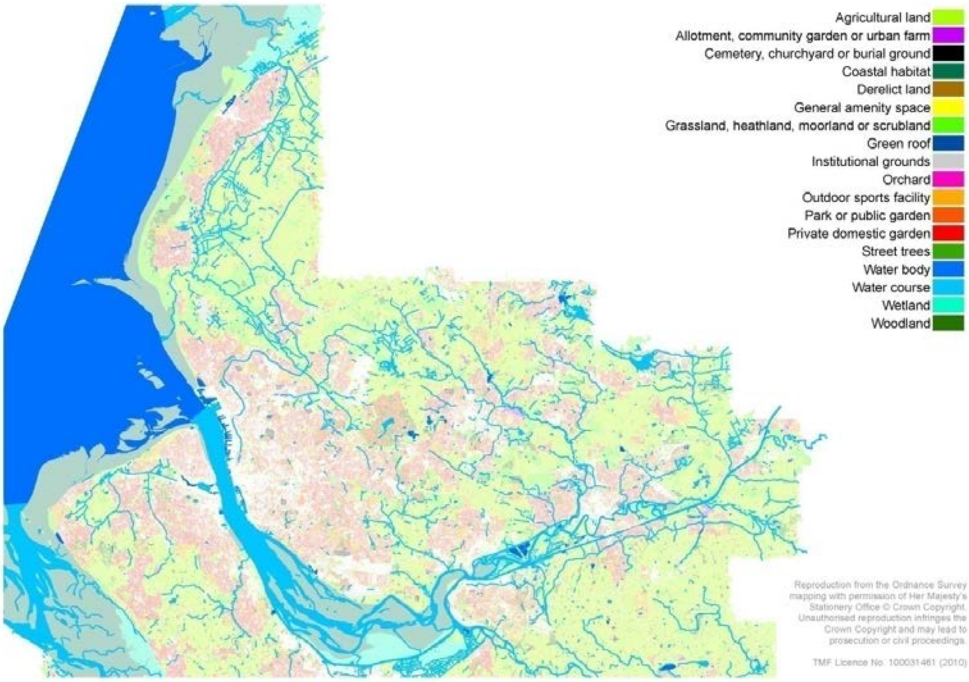
Map 12 shows the major concentrations of green infrastructure across the city region and Warrington which unsurprisingly form a ring around most of the urban areas, but do also break into the urban areas in many places providing a critical framework for the smaller scale green infrastructure within the urban. This map also indicates the position of the economic priority areas in the city region and Warrington in relation to the GI.

Map 12 Major concentrations of green infrastructure

The following broad conclusions can be drawn from Map 6:

- The importance of the Mersey and Dee estuaries.
- The urban areas are surrounded by green infrastructure predominantly agricultural in character with the gaps between settlements being of varying width.
- Importantly there are several corridors of varied typology breaking into and through the urban areas, for example in south Sefton along the Rimrose Valley, at several points along the eastern edge of Liverpool and North West and South East of Warrington Town Centre.
- The concentration of non-green infrastructure landward of the Mersey in Liverpool.
- The importance of private gardens in the overall GI mosaic of the city region.
- Reflecting the grain of urban development there is a south-west to north east trend in green infrastructure with the corridor between Knowsley and St Helens to the north and Halton/Warrington to the south being particularly prominent.
- North-south corridors although narrower and with pinch points are nevertheless of considerable significance for example between Liverpool and Widnes/Knowsley and to the east and west of St Helens and Warrington.
- The general proximity of GI to the areas identified as key economic priorities.

Map 13 Concentrations of green infrastructure - with water courses and water bodies emphasised



- With the exception of the Mersey and Manchester Ship Canal, there is a general northwest to southeast direction to the watercourses in the sub region. This may have implications for the future migration of species
- With the obvious exception of the Mersey itself there is a general paucity of watercourses within the Liverpool conurbation due previous culverting. Within the built up area the Leeds-Liverpool canal is a significant exception
- Watercourses can provide important linkages within urban areas as well as providing links to the surrounding countryside. This is particularly true for St Helens and Warrington as part of the Sankey catchment. The Sankey Valley is an important cross boundary feature linking Halton, Warrington and St Helens.

Green Infrastructure at Local Authority level

We can also look in detail at the individual local authorities green infrastructure typologies.

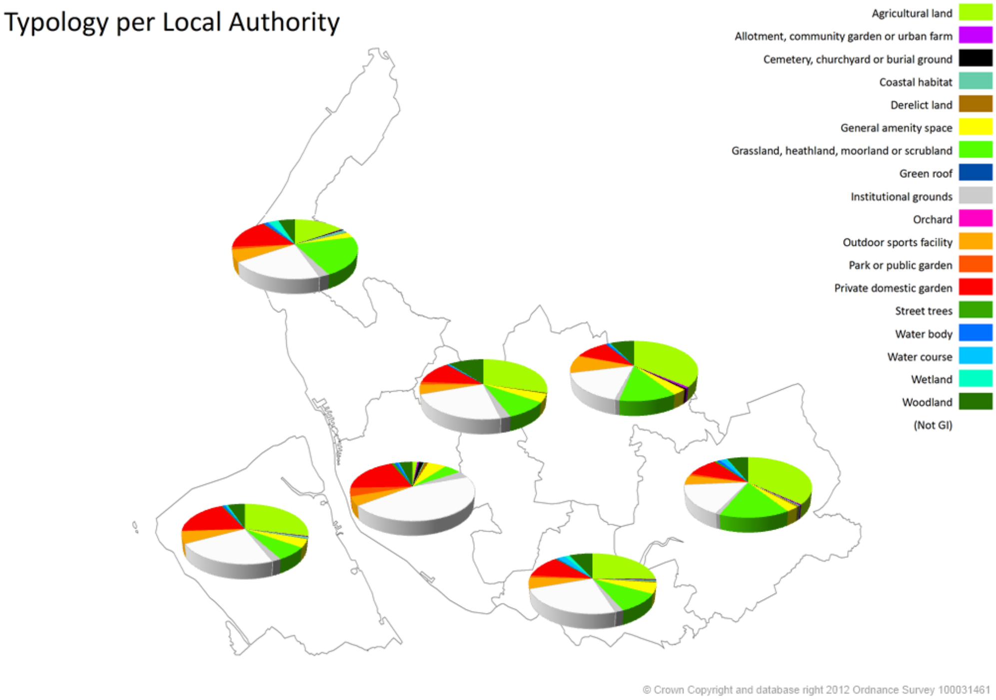


Figure 29 Typology by Local Authority

Type	Halton	Knowsley	Liverpool	Sefton	St Helens	Warrington	Wirral
Agricultural land	25.2%	29.6%	1.4%	15.4%	36.2%	36.6%	28.7%
Allotment, community garden or urban farm	0.3%	0.1%	0.5%	0.3%	0.8%	0.4%	0.3%
Cemetery, churchyard or burial ground	0.3%	0.1%	1.4%	0.4%	0.5%	0.1%	0.1%
Coastal habitat	0.8%	0.0%	0.4%	1.6%	0.0%	0.4%	1.1%
Derelict land	0.5%	0.3%	1.1%	0.2%	0.3%	0.5%	0.1%
General amenity space	5.8%	4.5%	5.6%	2.9%	3.0%	2.9%	4.4%
Grassland, heathland, moorland or scrubland	10.2%	9.5%	5.3%	21.4%	12.4%	15.3%	7.2%
Green roof	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Institutional grounds	1.8%	2.2%	3.7%	2.3%	1.0%	1.0%	2.0%
Not GI	24.5%	23.2%	45.3%	20.9%	17.0%	16.5%	23.3%
Orchard	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Outdoor sports facility	6.1%	5.3%	5.0%	6.7%	9.5%	5.1%	6.6%
Park or public garden	1.1%	1.5%	4.6%	1.4%	0.5%	1.1%	0.3%
Private domestic garden	11.6%	12.2%	19.1%	16.3%	10.1%	9.6%	18.8%
Street trees	0.3%	0.1%	1.0%	0.2%	0.1%	0.7%	0.3%
Water body	0.5%	0.3%	1.0%	1.2%	0.8%	1.2%	0.7%
Water course	2.4%	0.5%	0.5%	0.6%	0.4%	1.8%	0.5%
Wetland	1.5%	0.0%	0.0%	2.9%	0.2%	0.4%	0.4%
Woodland	7.0%	10.6%	4.1%	5.1%	7.3%	6.3%	5.2%

Figure 30 Halton typology

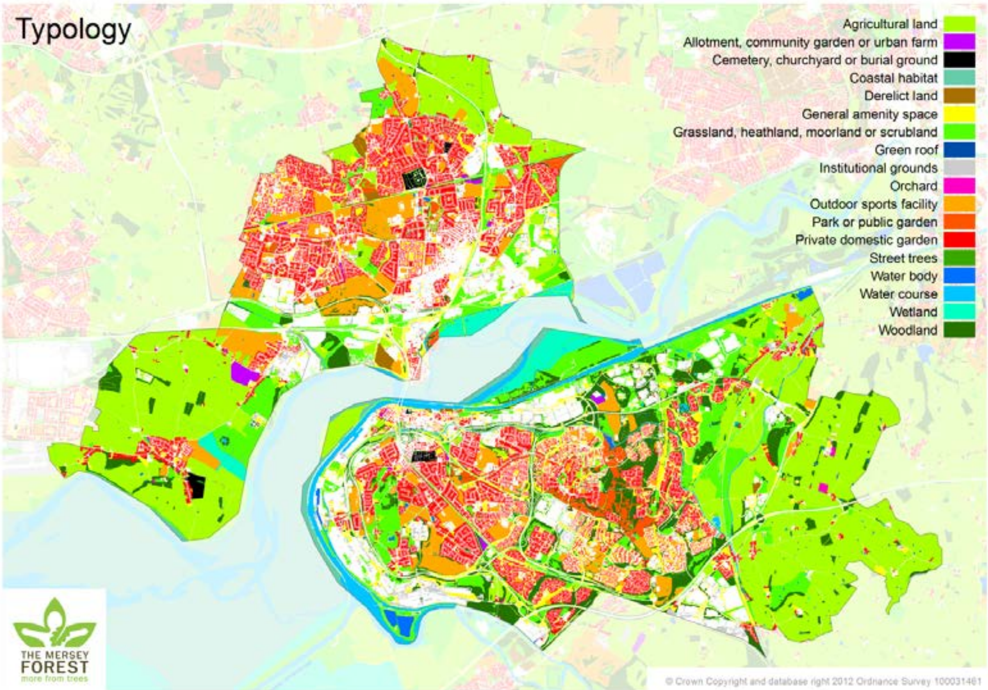


Figure 31 Knowsley typology

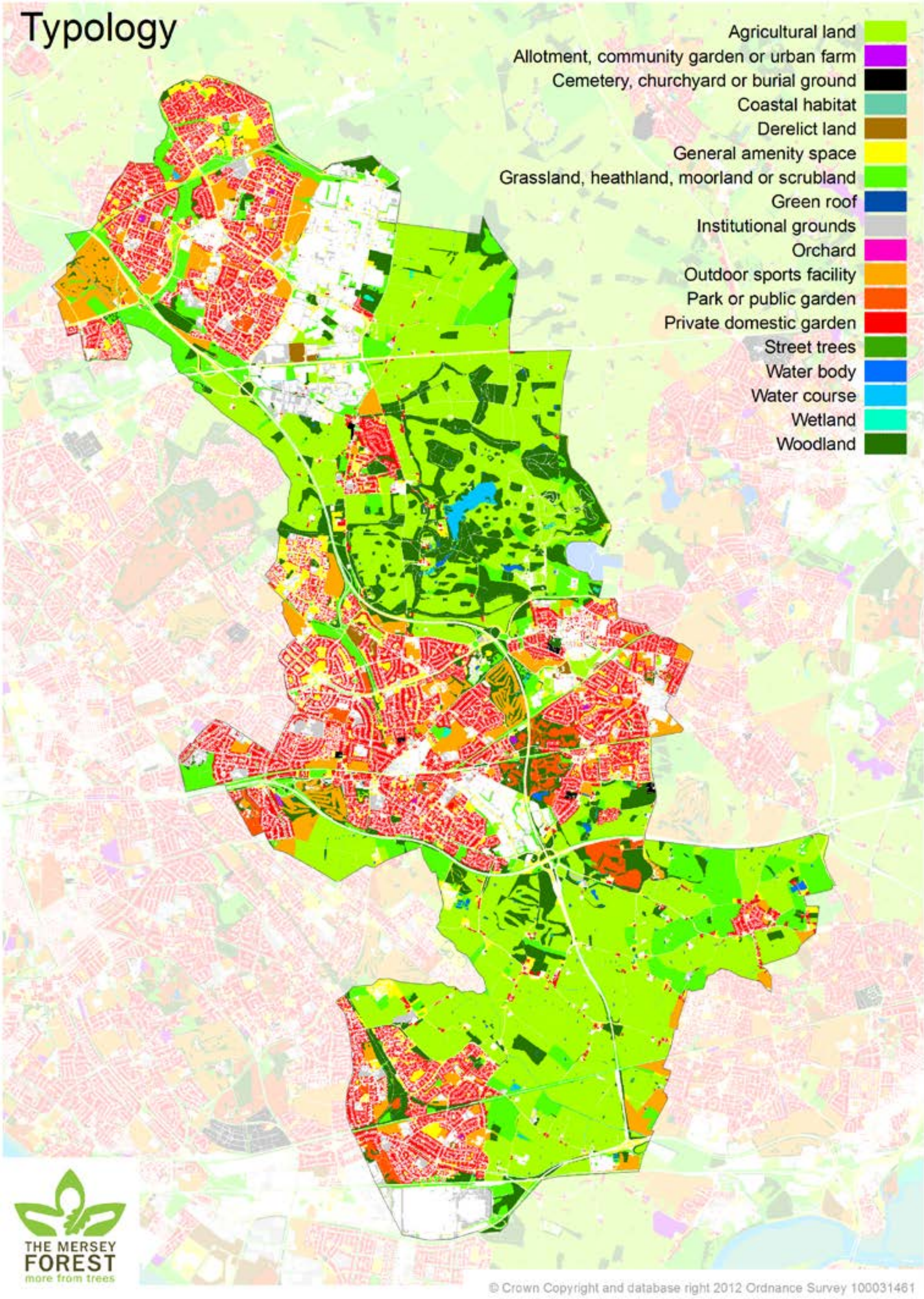


Figure 32 Liverpool typology

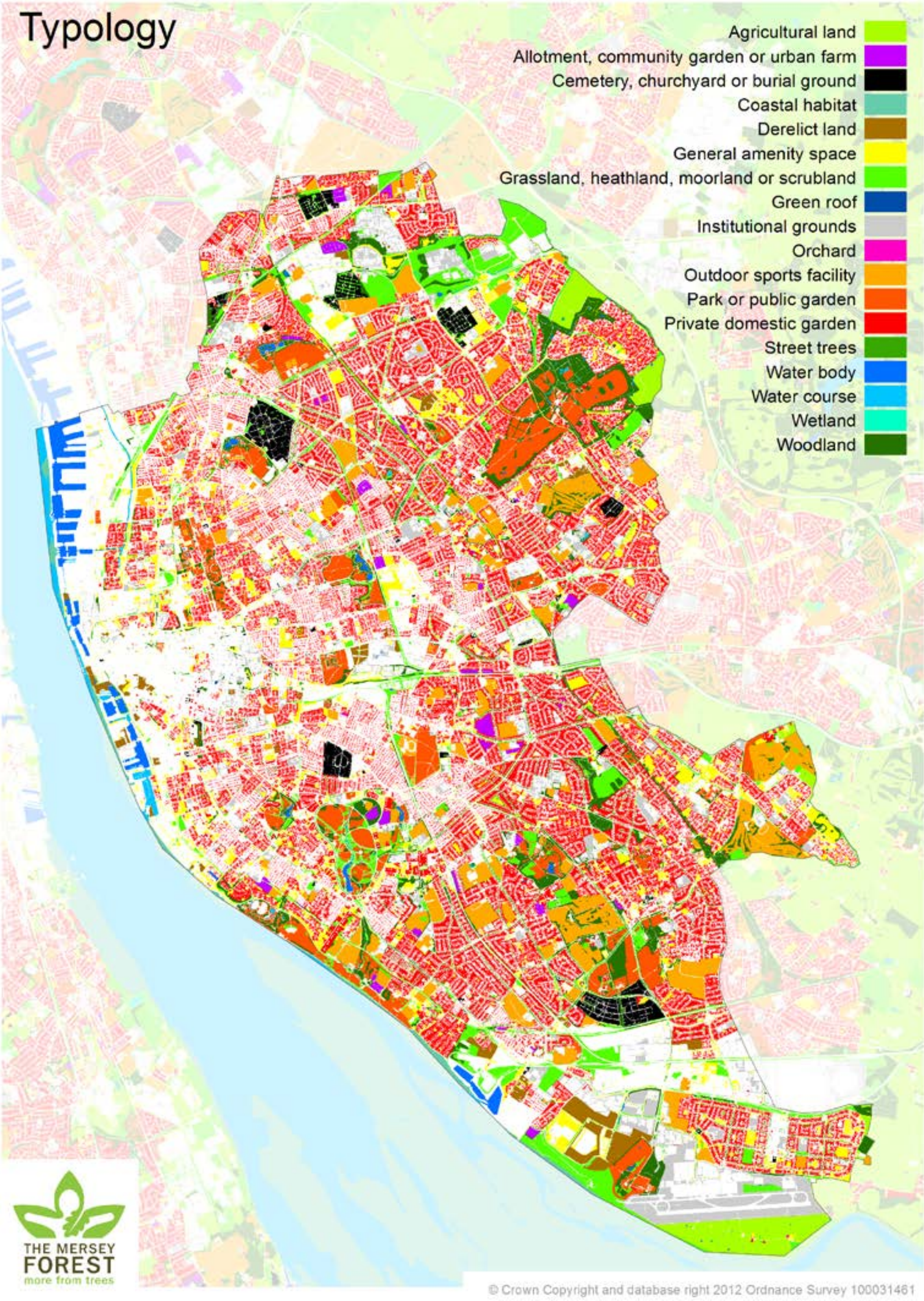


Figure 33 Sefton typology

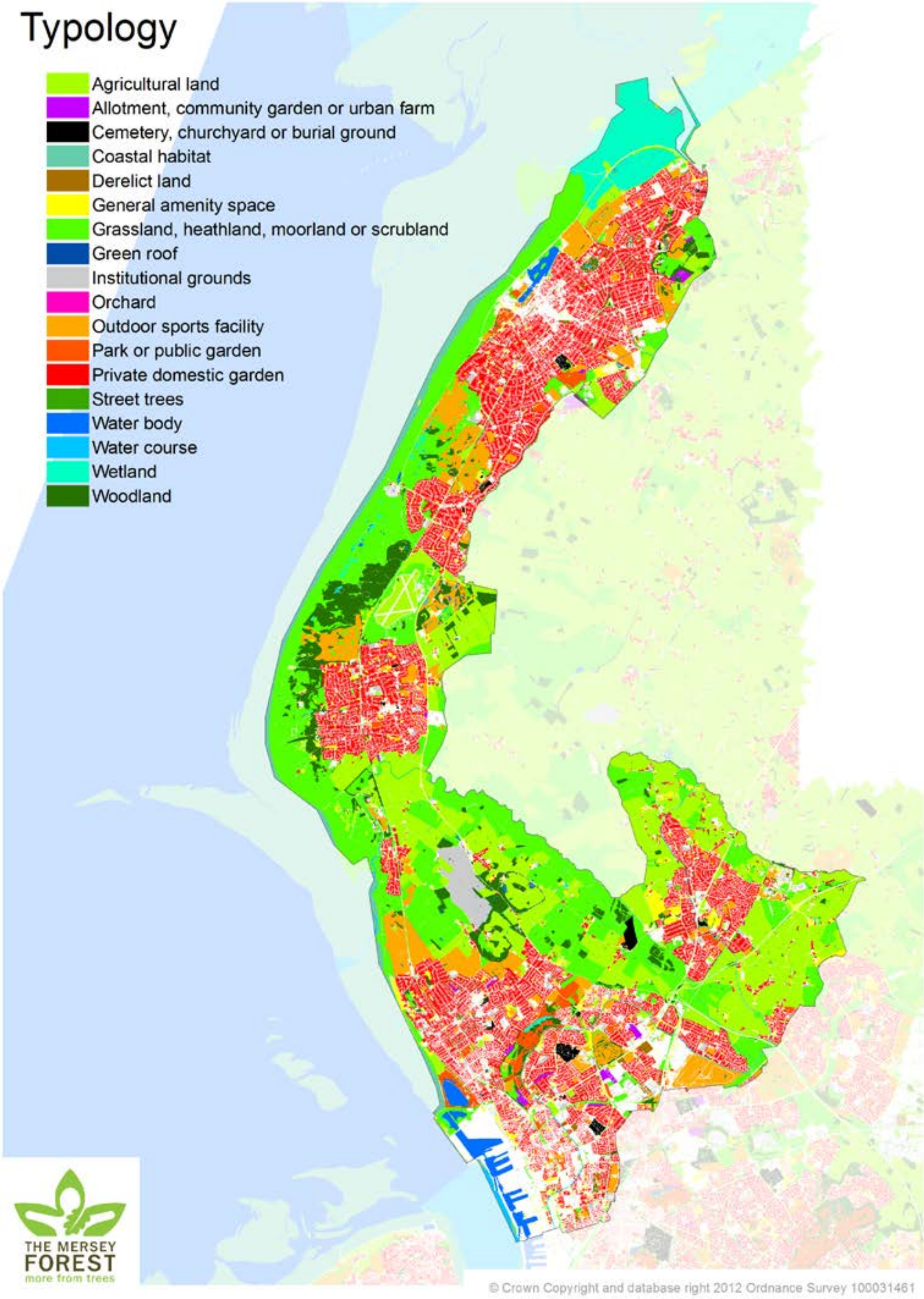


Figure 34 St Helens typology

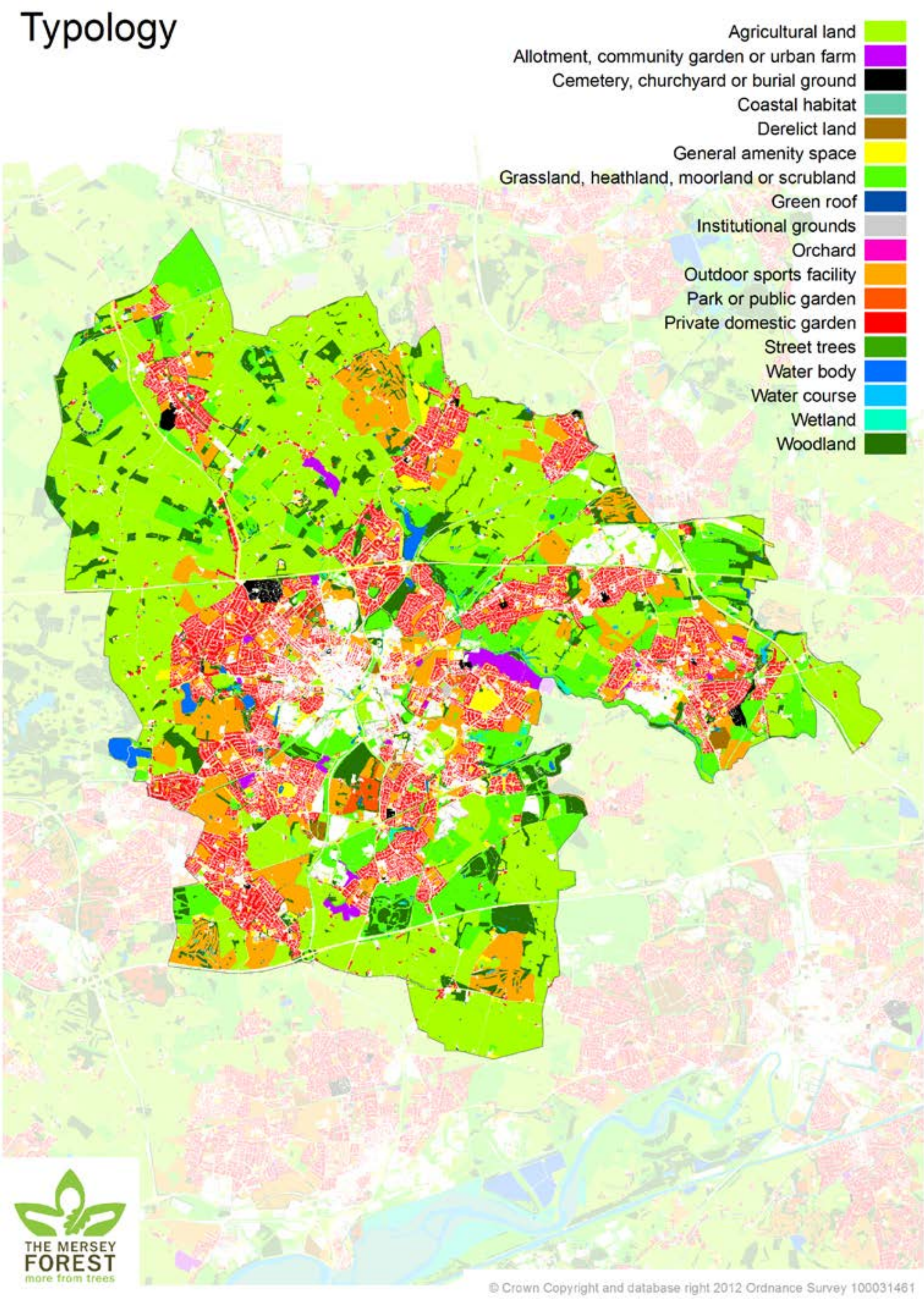


Figure 35 Warrington typology

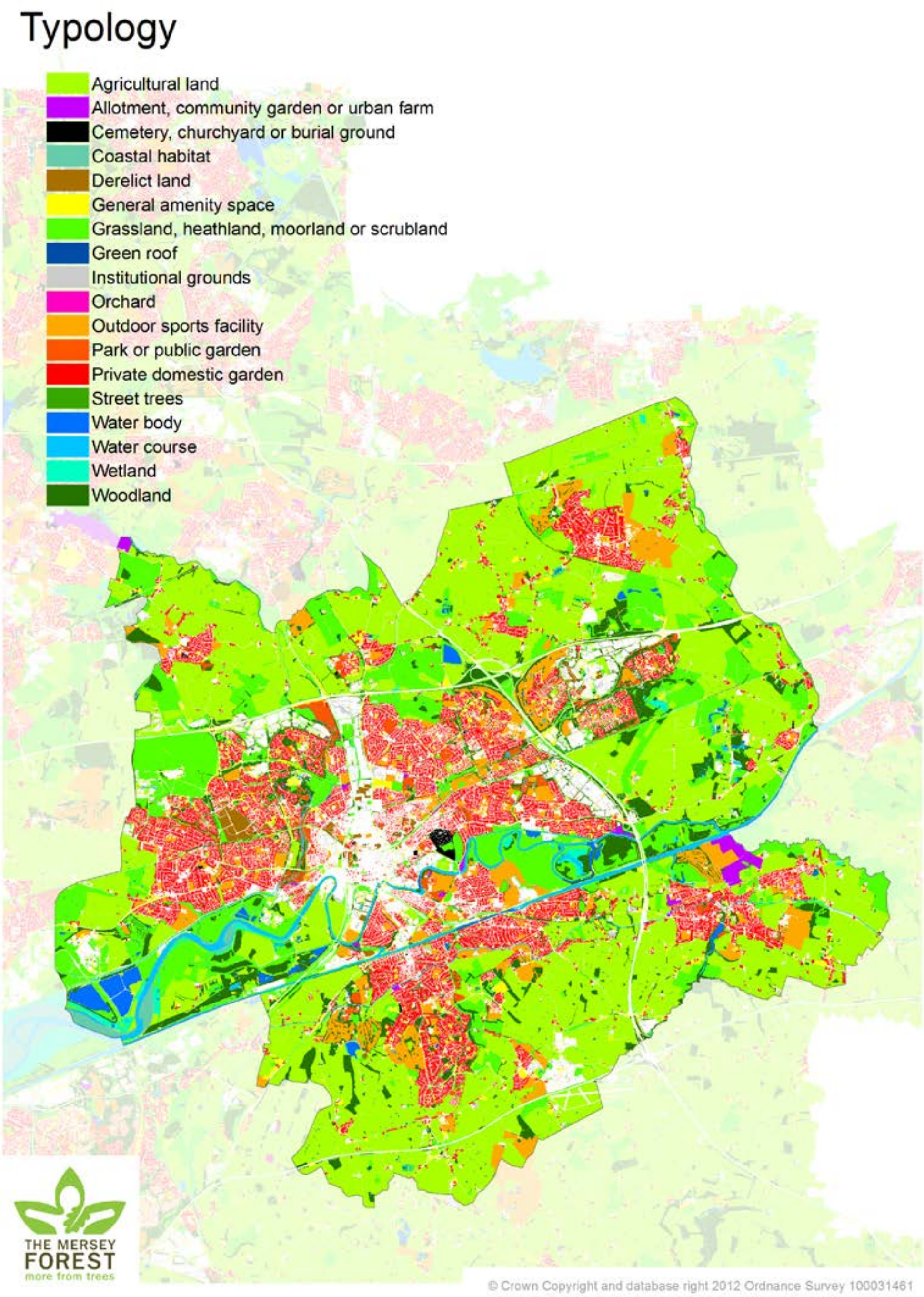
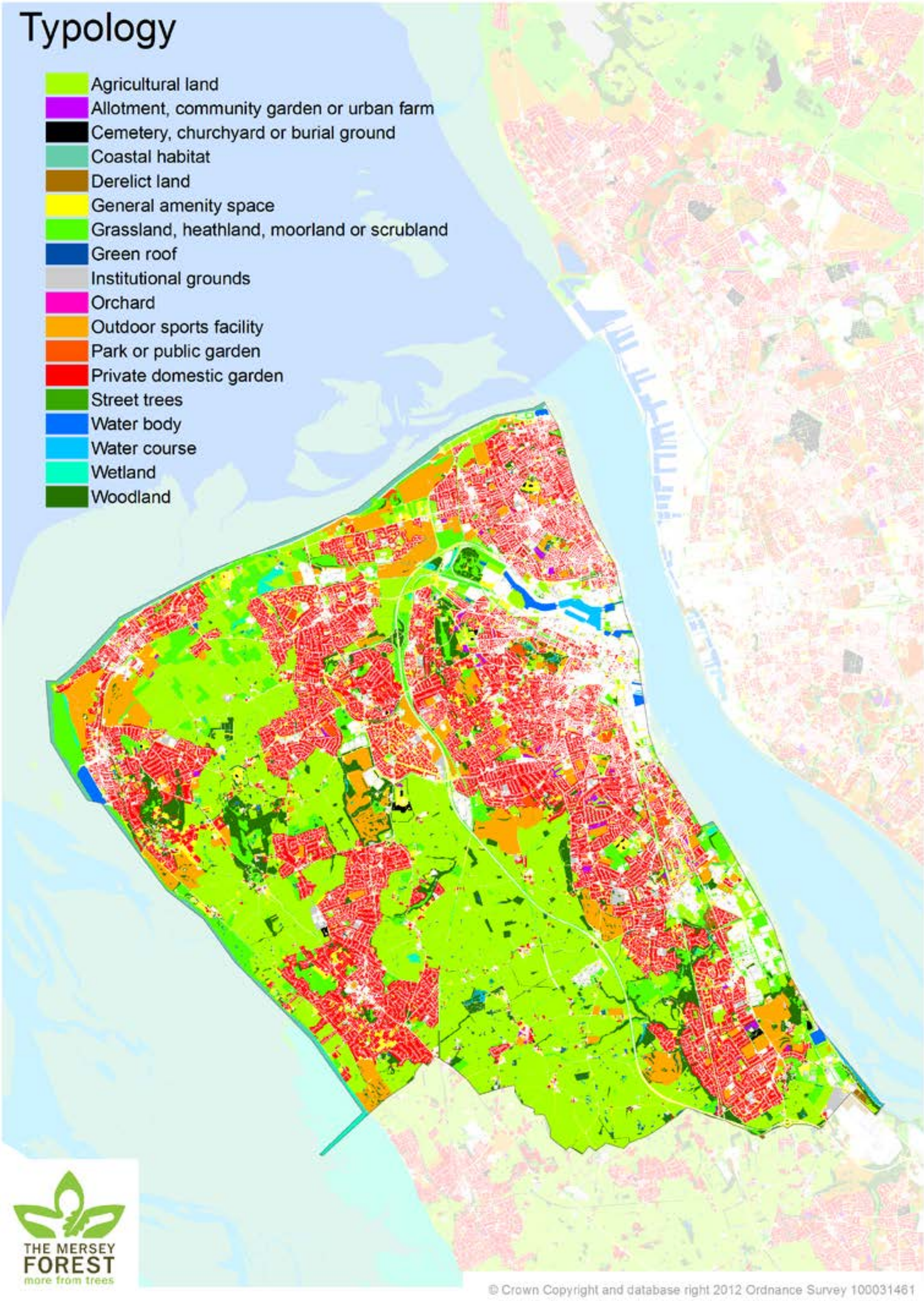


Figure 36 Wirral typology



The importance of agriculture in Warrington and St.Helens is shown in the typology data. The level of agricultural land in St.Helens is 25% greater than the next Merseyside authority (Knowsley 23%). The fact that Warrington and St.Helens have a common boundary also means that there are large tracts of agricultural land across the boundaries, reinforcing the need for collaborative working.

Coastal habitat is a major land use type that features predominantly for Sefton and Wirral. The coastal habitats have a key role to play in providing for coastal protection as well as a recreation and leisure resource that may come under increasing visitor pressure as the climate changes. It is of course also a habitat that has landscape and rich biodiversity both important assets for the city region.

Outdoor sports areas in St.Helens are almost twice the area of the other local authority areas. The other five authorities have very similar proportions of their land area providing sports facilities.

The area of private gardens is related to housing numbers and Liverpool has the highest area of private garden. In many green infrastructure and environment plans private gardens are often overlooked in assessing the resource, possibly because they are private, possibly because before now we have not had the capability to assess whether they are in fact green or completely paved etc., or simply because they have been forgotten. But our analysis indicates they are a major element of the overall green infrastructure.

Grassland, heathland, moorland or scrubland also comes out as a major typology, particularly in Sefton and Warrington. The type is most likely to be grassland and there may be some areas that should be identified as “Agricultural” land type. More analysis is required to look at the basis for this and to relate it in particular to the information provided for the ecological framework from MEAS.

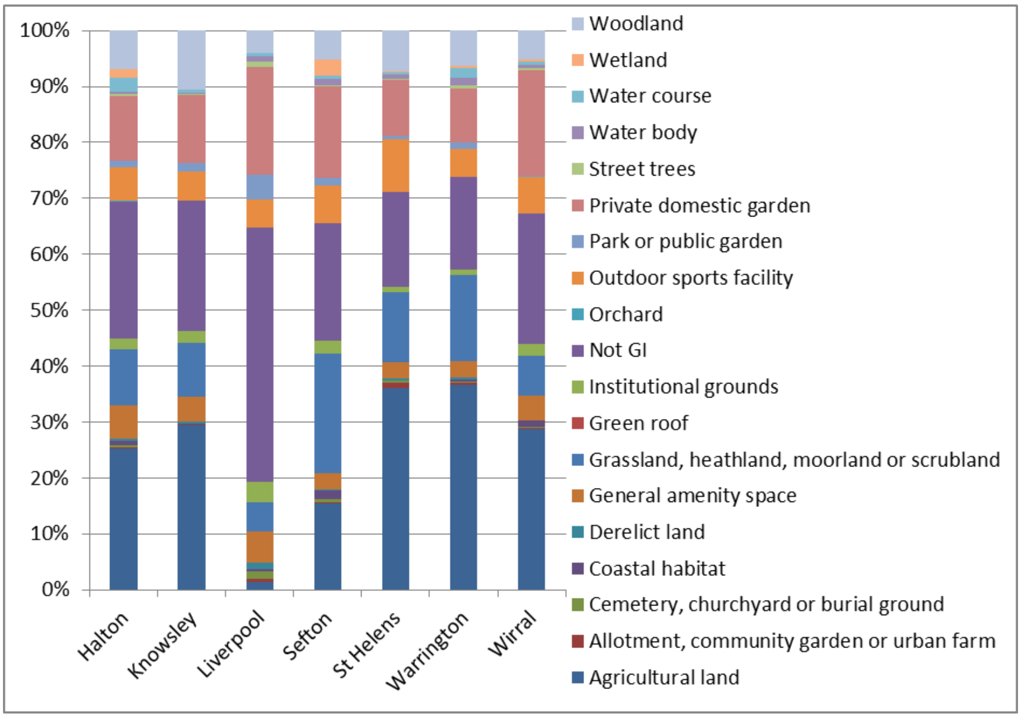


Figure 37 Cumulative GI by Local Authority

Since 2004 years over five million new trees have been planted across the area of this study through the delivery of The Mersey Forest Plan, increasing woodland cover by 72% from the 1991 baseline of 3.8% to the present value of 6.5%.

Knowsley at 10.6% is now at the national (England) average for woodland cover which is 10.0%[282]. Knowsley Park Estate constitutes 27% of Knowsley's total woodland cover.

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282 Forestry Commission (2012,) Woodland Area, Planting & Restocking - 2012 edition. Available at: http://www.forestry.gov.uk/forestry/INFD-8GKKG4

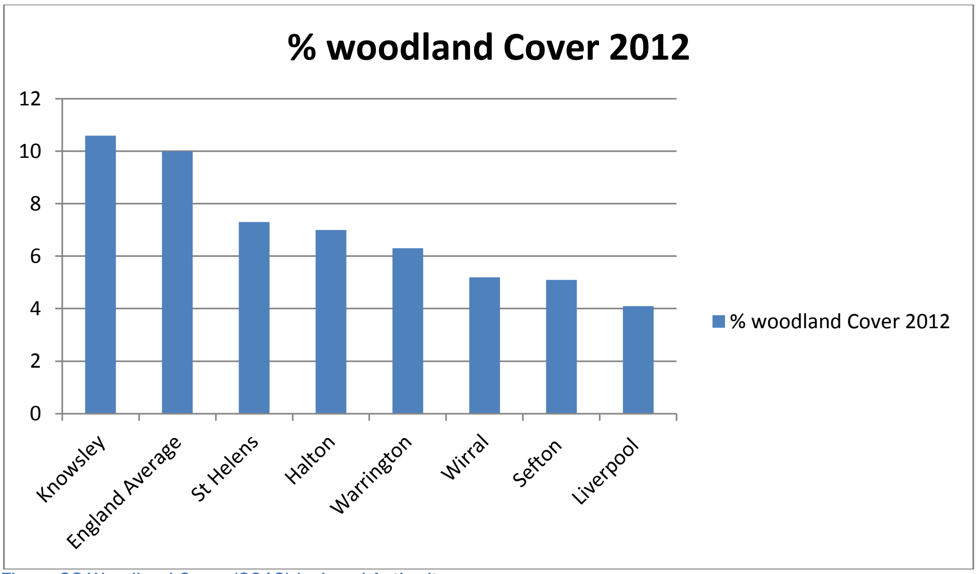


Figure 38 Woodland Cover (2012) by Local Authority

The Mersey Forest comparator study[283] highlighted the fact that woodland planting had been lower on Wirral. Wirral is not yet part of The Mersey Forest Partnership and so will not have had the targeted grant funding, targeted support etc.

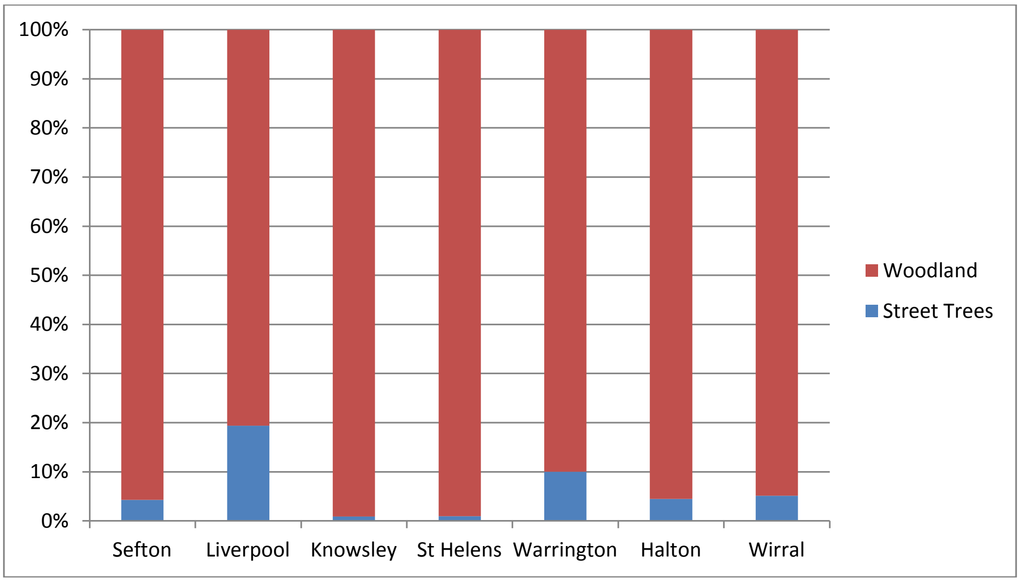
Urban Trees

The Liverpool City Region GI Framework has provided an opportunity to look in detail at the urban tree population for the first time at this scale.

There are marked variations in the street tree cover as a percentage of overall tree and woodland cover, with twice (Warrington) or three times (Liverpool) the level of street tree cover as the other boroughs.

283 TEP (2006) Mersey Forest Comparator Study Available at: http://www.merseyforest.org.uk/files/1213.018%20FINAL%20REPORT.pdf

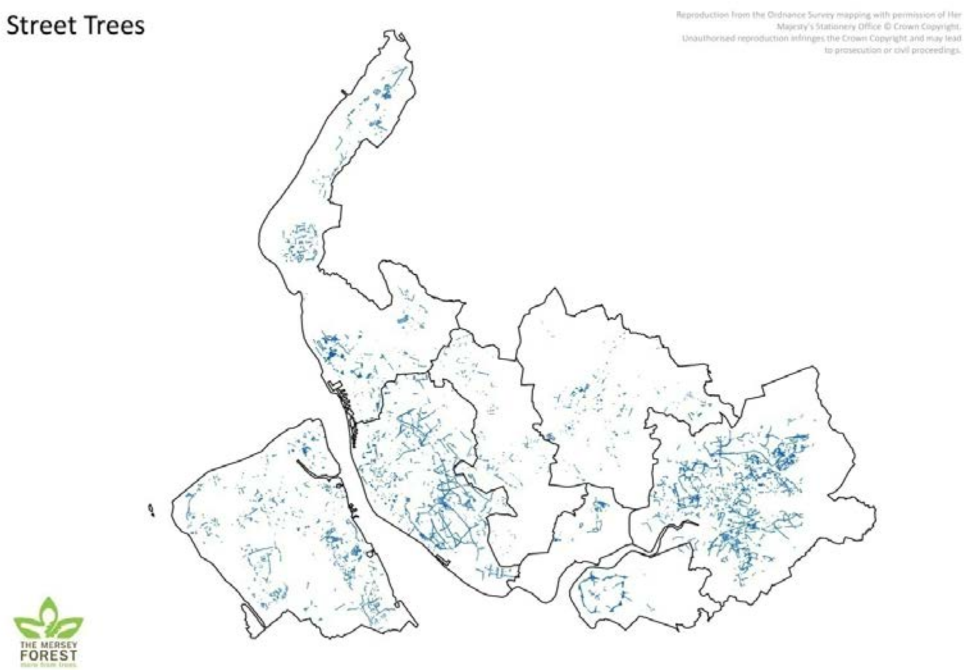
Figure 39 Woodland and Street Tree split by local authority



	Sefton	Liverpool	Knowsley	St.Helens	Warrington	Halton	Wirral
	%	%	%	%	%	%	%
Street Trees	0.2%	1.0%	0.1%	0.1%	0.7%	0.3%	0.3%
Woodland	5.1%	4.1%	10.6%	7.3%	6.3%	7.0%	5.2%

The distribution of the street trees is shown in Figure 40 Distribution of Street Trees.

Figure 40 Distribution of Street Trees



In summary

- The distribution of green infrastructure ranges from a high of 84% in the Wirral to a low of 61% in Liverpool. Given the urbanised character of Liverpool this still represents a significant total
- Within the urban areas private gardens are the largest green infrastructure typology ranging from 9% in Warrington to 16% in Liverpool. This is an easily overlooked resource which actually represents a major element of the overall green infrastructure
- Agriculture is particularly important in Warrington (36%) and St Helens (36%) with the level 25% greater than in the next authority (Knowsley 23%). Agricultural land and associated economic activities is a key issue for the region as demonstrated by the Merseyside Rural Economy Action Plan.
- Coastal habitat is a major land use in Sefton (22%) and Wirral (25%). These habitats have a key role to play in providing coastal protection and leisure, landscape and biodiversity assets for the city region
- Knowsley (10.6%) is now above the woodland national average and St Helens (7.3%) has transformed many areas of derelict land to community woodland with the City Growth Strategy containing a programme to support St Helens as “Town in the Forest”. The other authorities are within the range 4.1 % (Liverpool) to 7 % (Halton).
- Street trees are less significant in extent in the central part of the city region. The New Town approaches to urban greening in Halton and Warrington are clearly seen on the map with the urban pattern shown up through the street tree distribution. Liverpool and some parts of Wirral also show higher levels of street trees.

Derelict land

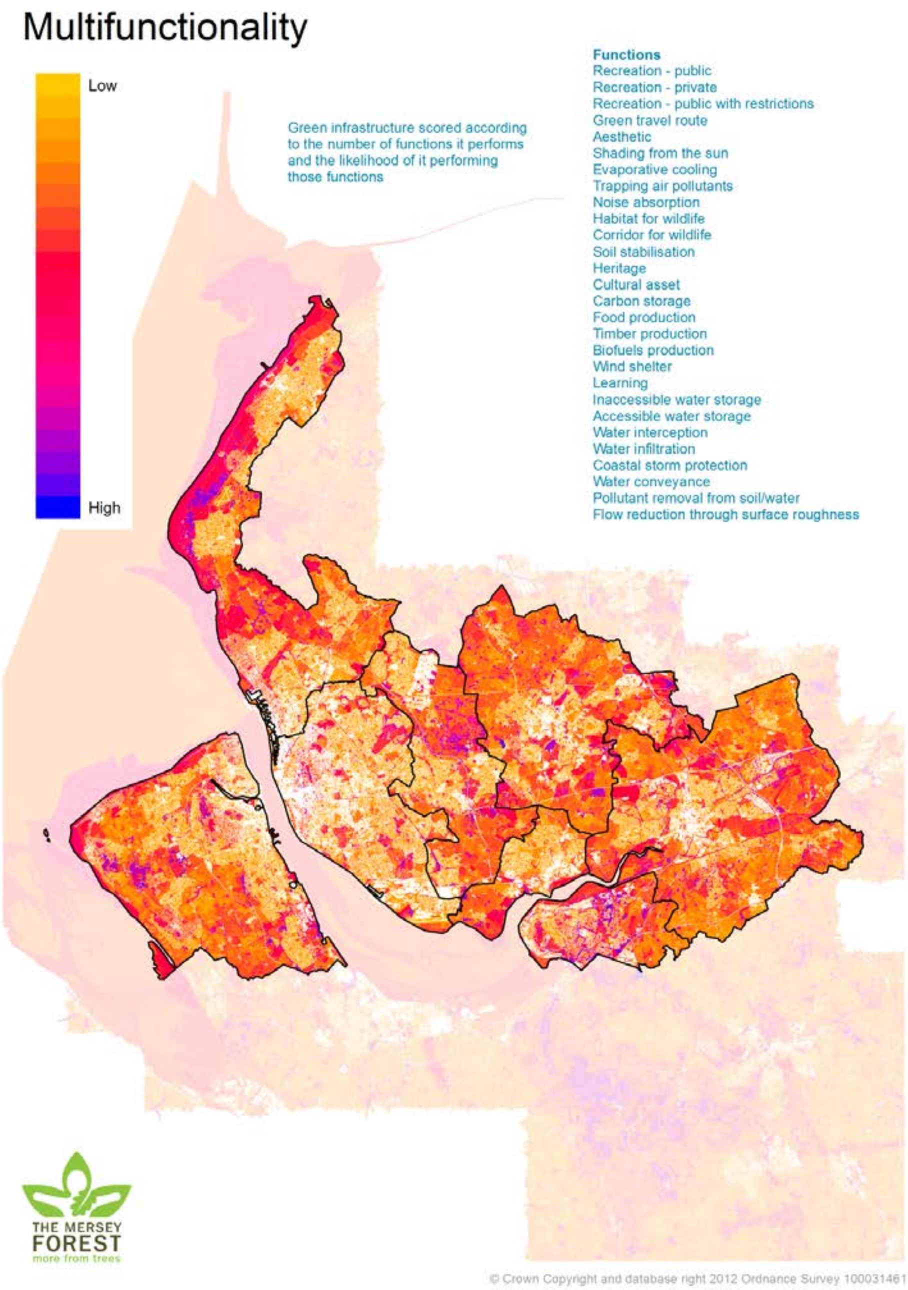
It is worth commenting in particular on the derelict land type. There is a difference between the areas that the local authority would class as derelict land and the areas of land that this study has classed as derelict. The difference is due to a disparity in the technique for identifying derelict land. In this framework local authority classified derelict land may be shown as a different type of green infrastructure, for example, woodland.

These may be areas of previously derelict land that have naturally regenerated with woodland. For the framework we need to identify functionality of the green infrastructure; therefore it is important that the green infrastructure type is identified correctly. In this example the derelict land functions are related to the presence of the woodland.

Taking this approach may at first seem to cause confusion, but the results that are achieved in terms of green infrastructure planning are more robust and accurate and it is straightforward to separate designation in planning from a green infrastructure function.

Functionality

Map 14 provides a view of the overall multi-functionality of the green infrastructure across the city region. This map simply displays all of the 28 function layers, with no weighting of the functions. The map shows how many functions are provided on each individual area of green infrastructure.



Some concentrations tend to stand out on immediate inspection:

- Sefton coast including woodlands
- Knowsley Estate
- Wirral (Dee) coast

- Newton/Haydock Park area
- Rainhill/Knowsley area
- Thurstaston, Arrowe Park and Caldy area of West Wirral

Others emerge on closer examination including:

- Leeds/Liverpool canal corridor in Sefton
- Agricultural land north of Netherton/woodlands at Ince Blundell
- Croxteth Park area
- Isolated sites within urban areas including Liverpool parks –green curve
- M57 corridor Knowsley – and down to Cronton area
- Corridor through Kirkby
- Mersey frontage Widnes
- Network of green corridors in Runcorn around Manor Park and Norton Priory
- Sankey Valley Park in Warrington and St.Helens
- Mersey Valley eg. Moore area
- South St.Helens: Bold Forest Park
- Rimrose Valley

This information has been assessed against a wide range of socio-economic and environmental data for each of the six priorities for the framework to provide information on "Assets" and "Pinch Points."

Map 14 shows the areas of concentration of functions and highlights the significance of the Liverpool, Sefton and Wirral Coastline as the largest area of high functionality in the city region and Warrington.

The other areas of concentration are both smaller in extent and scattered across the city region and Warrington.

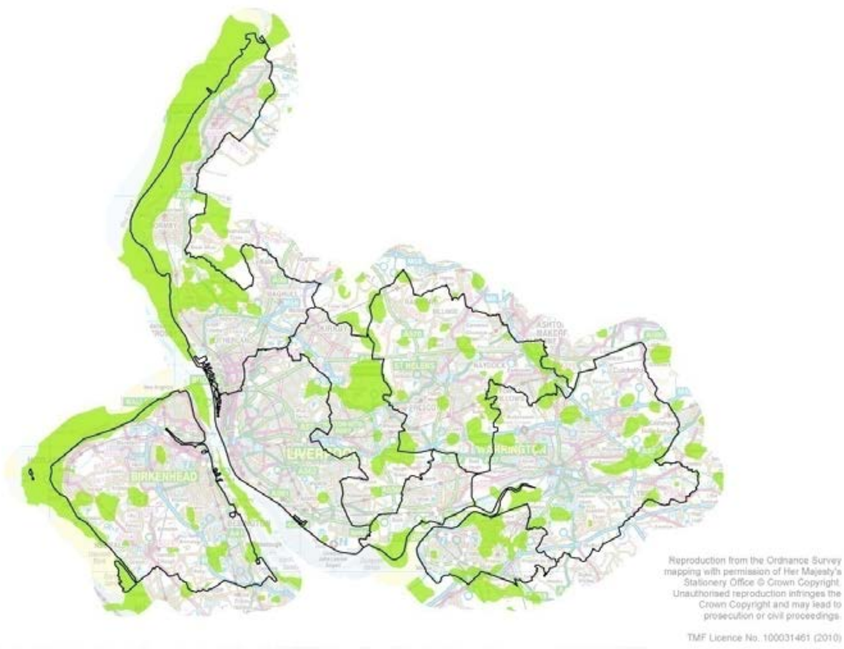
Comparing this map with the major concentrations of GI types (Map 12) highlights the low levels of multifunctionality of the agricultural land in the city region. An obvious reason for this is the focus on the food growing. A challenge for the city region is to increase the functionality of these areas with compromising the agricultural businesses and the production of food.

The river corridors do not stand out as being major concentration along their whole length.

The Ecological Framework Core Biodiversity Areas contain many of the areas of high functionality concentration, but also 42% is outside of these areas of concentration.

GI planning and project delivery should aim to increase functionality where possible (and needed), but only insofar as it does not compromise the key function for that area, such as food growing or the safeguarding of a particular important habitat etc.

Map 14 Major concentrations of high green infrastructure functionality



From this map we can see concentrations of GI functionality in the following local authority areas:

Wirral

- North and west coasts
- Gayton Sands
- River Mersey
- Caldy Hill, Thurstaston Common, Royden Park and Arrowe Park
- Raby Mere
- Eastham Park

Sefton

- The coast
- Ince Blundell, Lunt and Little Crosby
- Churchtown Moss

Liverpool

- Croxteth Park
- Woolton Wood

Knowsley

- Knowsley Park
- Tarbock Hall to Cronton
- Kirkby Moss

Halton

- Norton Priory, Wigg Island and Daresbury Firs
- Hale Head and Pickering's Pasture
- Clifton and Murdishaw Wood

St Helens

- Bold Forest Park
- Blundell's Hill
- Mossland to the west of Rainford
- Holiday Moss
- Carr Mill Dam and Stanley Bank Farm
- Haydock Park
- Newton Park

Warrington

- Moore Nature Reserve
- Hill Cliffe
- The Eyes and Rixton Halls
- Rixton Moss
- Risley Moss
- Myddleton Hall
- Omega

One disadvantage of this assessment is that it removes isolated high function GI such as the larger Liverpool parks.

Issues arising

- Recognising that the above analysis does not introduce weighting nor relates function to need it does indicate those areas where policy makers may wish to consider weighting their policies toward protection of GI functionality
- For the majority of the city region, both within the urban and rural areas, the primary objective will be to explore opportunities to increase the multifunctionality of the green infrastructure

Green infrastructure multifunctionality for each of the priorities

Green infrastructure multifunctionality can be assessed in detail for each of the six priorities. For each priority a map showing where functionality is currently being performed by green infrastructure is provided. Table shows the range of functions that have been used to create each map.

Once again it is important to highlight that the individual functions used for these multifunctionality maps are not weighted.

Table 10 Functions used to create multifunctionality maps for each of the six priorities

	FUNCTION																											
PRIORITY	recreation - public	recreation - private	recreation - public with restrictions	green travel route	aesthetic	shading from sun	evaporative cooling	trapping air pollutants	noise absorption	habitat for wildlife	corridor for wildlife	soil stabilisation	heritage	cultural asset	carbon storage	food production	timber production	biofuels production	wind shelter	learning	inaccessible water storage	accessible water storage	water interception	water infiltration	coastal storm protection	water conveyance	pollutant removal from soil/water	flow reduction through surface roughness
Setting the Scene for Growth	■			■	■															■								
Supporting Adaptation to Climate Change	■	■	■			■	■			■	■	■									■	■	■	■	■	■	■	■
Providing Recreation, Leisure and Tourism	■	■	■	■									■	■														
Enhancing the Ecological Framework										■	■																■	
Developing the Rural Economy	■		■									■	■	■		■	■	■			■			■				
Supporting Health and Well-being	■	■	■	■	■	■	■	■	■							■				■								

The following sections take each of the priorities in turn to show and comment on the multifunctionality of the GI in relation to that priority.

Setting the Scene for Growth

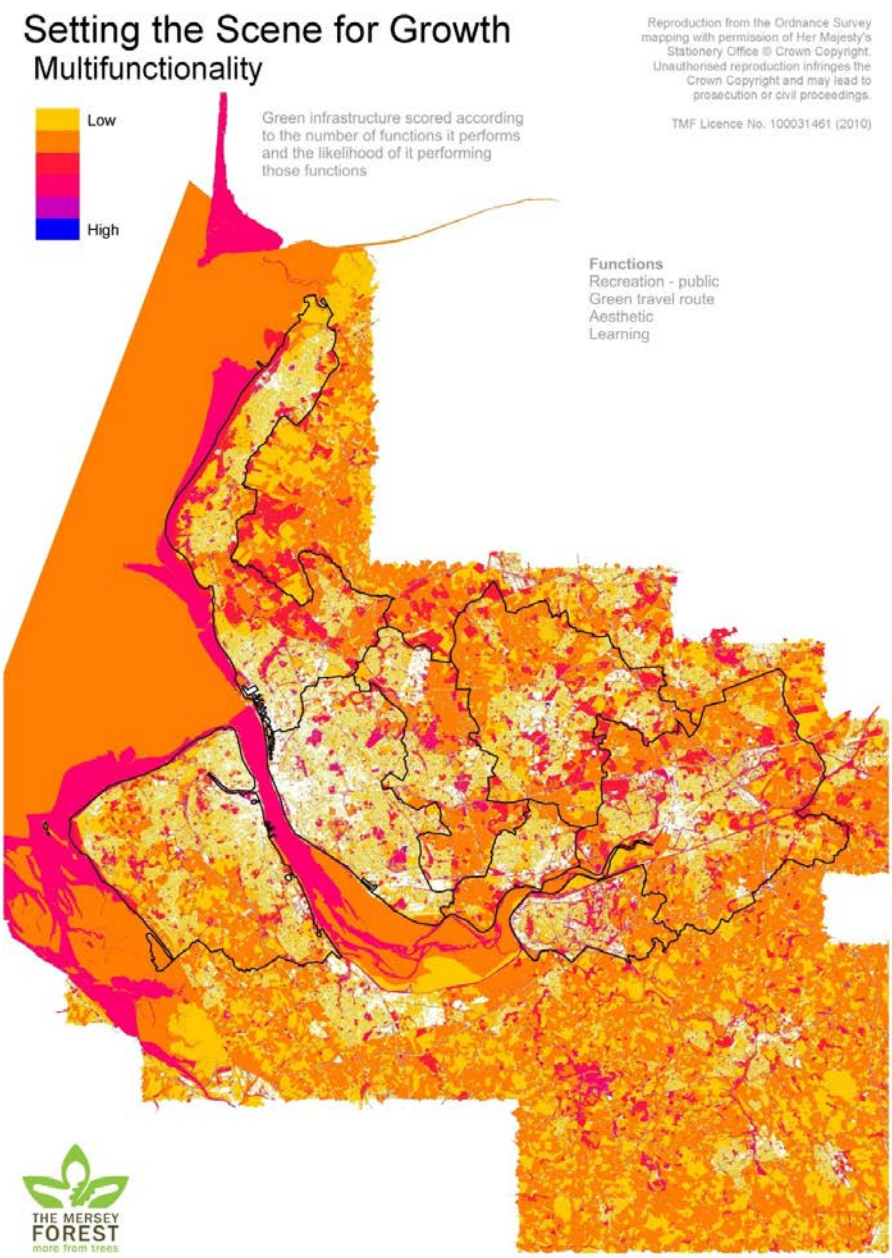
Four functions are assessed and mapped (Map 15) for Setting the Scene for Growth:

- Recreation (public)
- Green Travel Route
- Aesthetic
- Learning

It has been highlighted earlier in this document that many other functions also impact on setting the scene for growth and in the final assessments of actions it is important to make the link between the functions across different priorities, For example, health and wellbeing functions have a key role to play in improving productivity; water management can reduce flood risk and make an investment opportunity more realistic.

Aesthetic is the Liverpool City Region's most problematic function to assess as there is no agreed way of comparing the aesthetics of green infrastructure and certainly not of comparing, on the same scale the aesthetic quality of a city centre tree to rural woodland or to a coastal habitat.

More work is needed to improve our mapping and understanding of this function in particular. It is of central importance to identifying where we need to target interventions to improve quality of place.



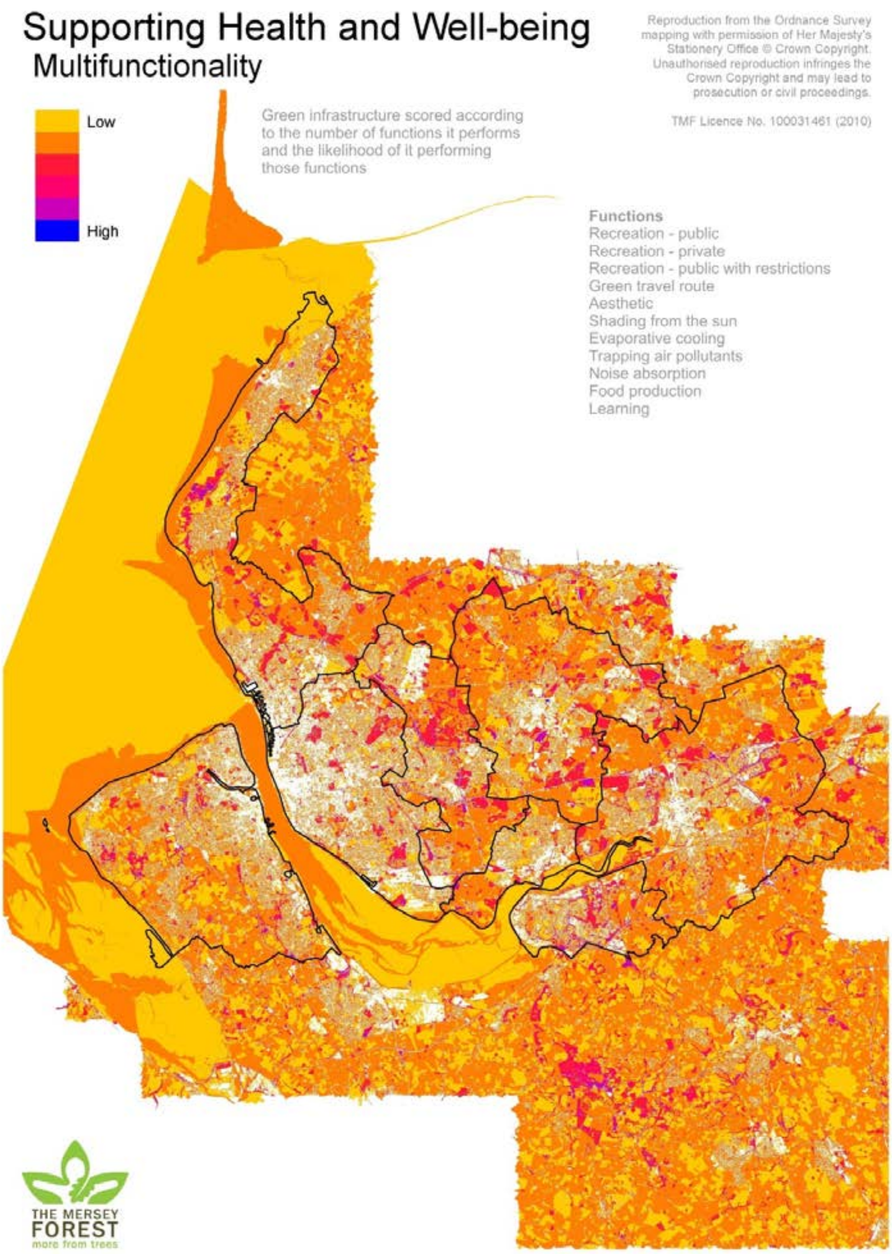
Map 15Setting the Scene for Growth Multifunctionality across the city region

Map 15 shows the importance of areas such as Rimrose; Sefton Meadows; Croxteth Park; Omega, Warrington and Bold Forest Park, St.Helens and the arc of GI running around the Liverpool City boundary and up into south St Helens.

The importance of the coast and the major parks, as well as the agricultural land around Warrington, along the M62 and the northern area around Rainford in St.Helens and west of Kirkby in Knowsley are also shown as being comparatively multifunctional.

Supporting Health and Wellbeing

Eleven functions are assessed for this priority and these are identified on Map 16



Map 16 Supporting Health and Wellbeing Multi-functionality across the Liverpool City Region

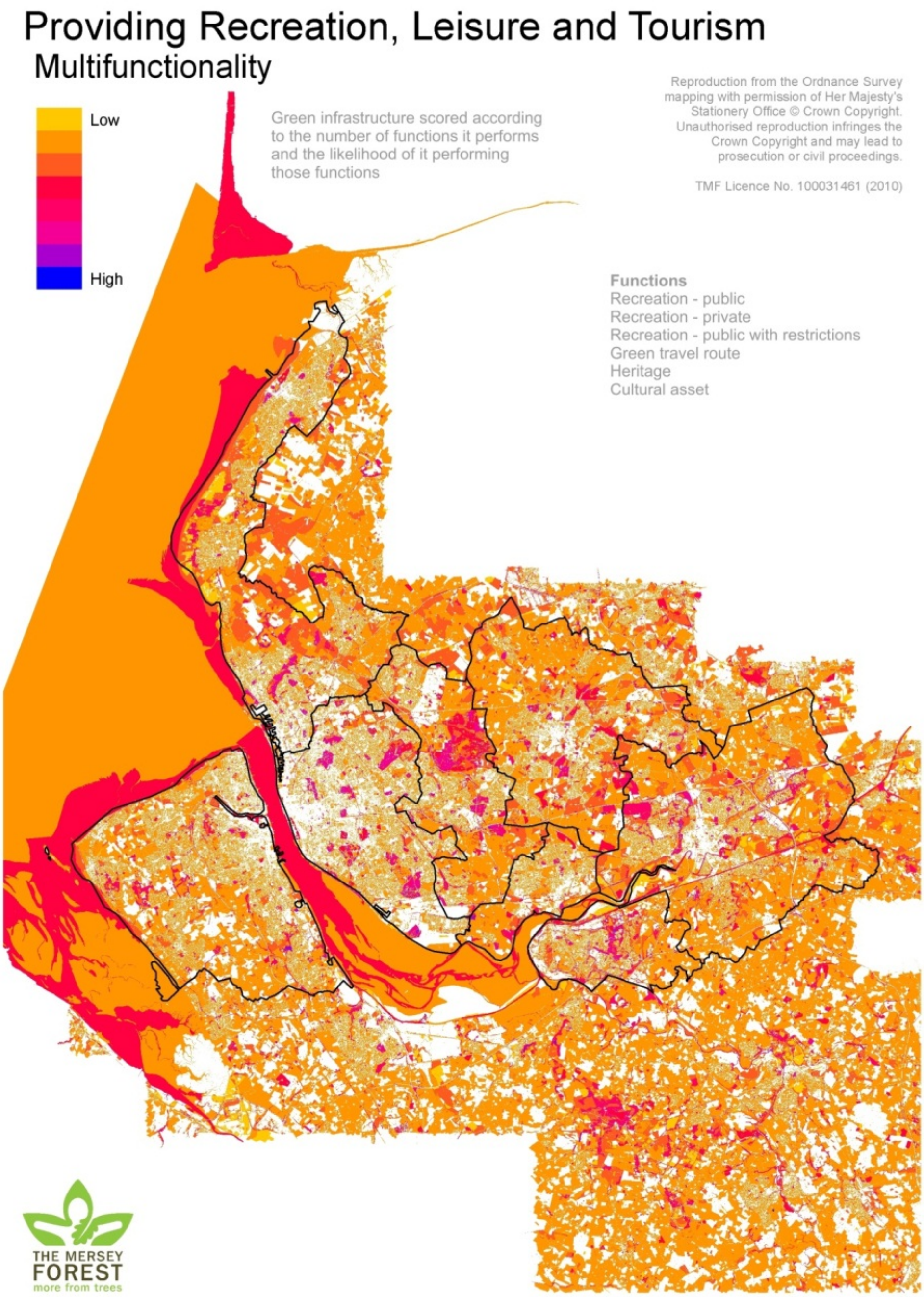
The areas of high functionality for health and well-being as the Sefton Coast woodlands; Ince Blundell; Rimrose; M57 corridor and Knowsley Estate; Sherdley Park, Bold Forest Park, St.Helens; Thurstaston and Caldy, Wirral and green corridors around Manor Park and Norton Priory in Runcorn.

The major parks across the city region and Warrington stand out as highly multifunctional areas for this priority.

Areas of low functionality are seen in our towns and cities and along both the north and south banks of The Mersey from Bootle and Birkenhead to Warrington.

Providing Recreation, Leisure and Tourism

Six functions are assessed for this priority as shown on Map 17



Map 17 Supporting recreation tourism and leisure across the city region and Warrington.

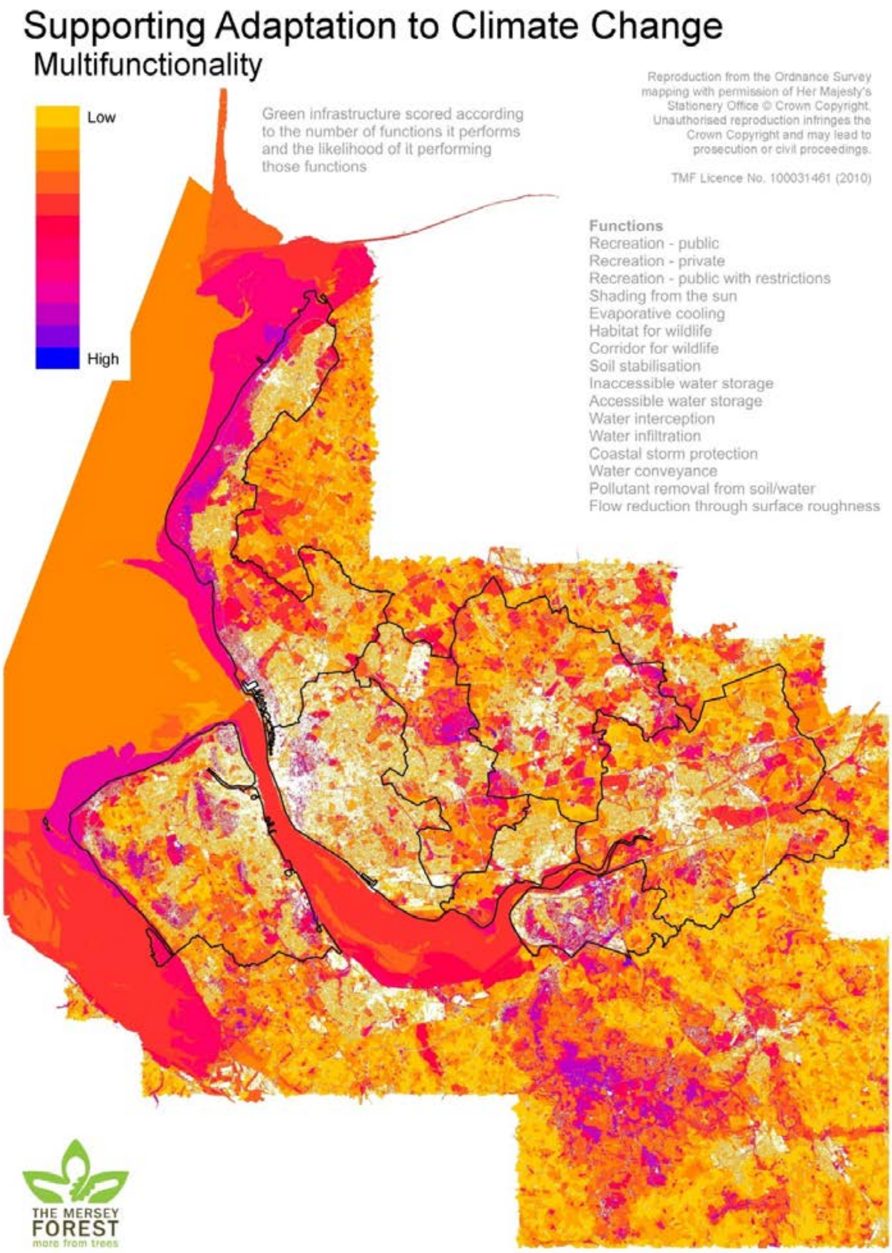
Areas such as Sefton Coast Woodlands and Rimrose Country Park in Sefton; the Knowsley Estate; Sherdley Park and Carr Mill Dam in St.Helens and parks in Liverpool including Sefton, Croxteth, Allerton, Woolton and Calderstones to provide areas of high functionality for recreation, tourism and leisure. Other areas clearly shown include the green corridors around Manor Park and Norton Priory in Runcorn and Sankey Valley in Warrington.

The River Mersey itself is identified as having high functionality.

Less functionality is found in Liverpool City centre and Birkenhead.

Supporting Adaptation to Climate Change

Sixteen functions are used to assess this priority as shown on Map 18



Map 18 Supporting Adaptation to Climate Change Multi-functionality across the Liverpool City Region

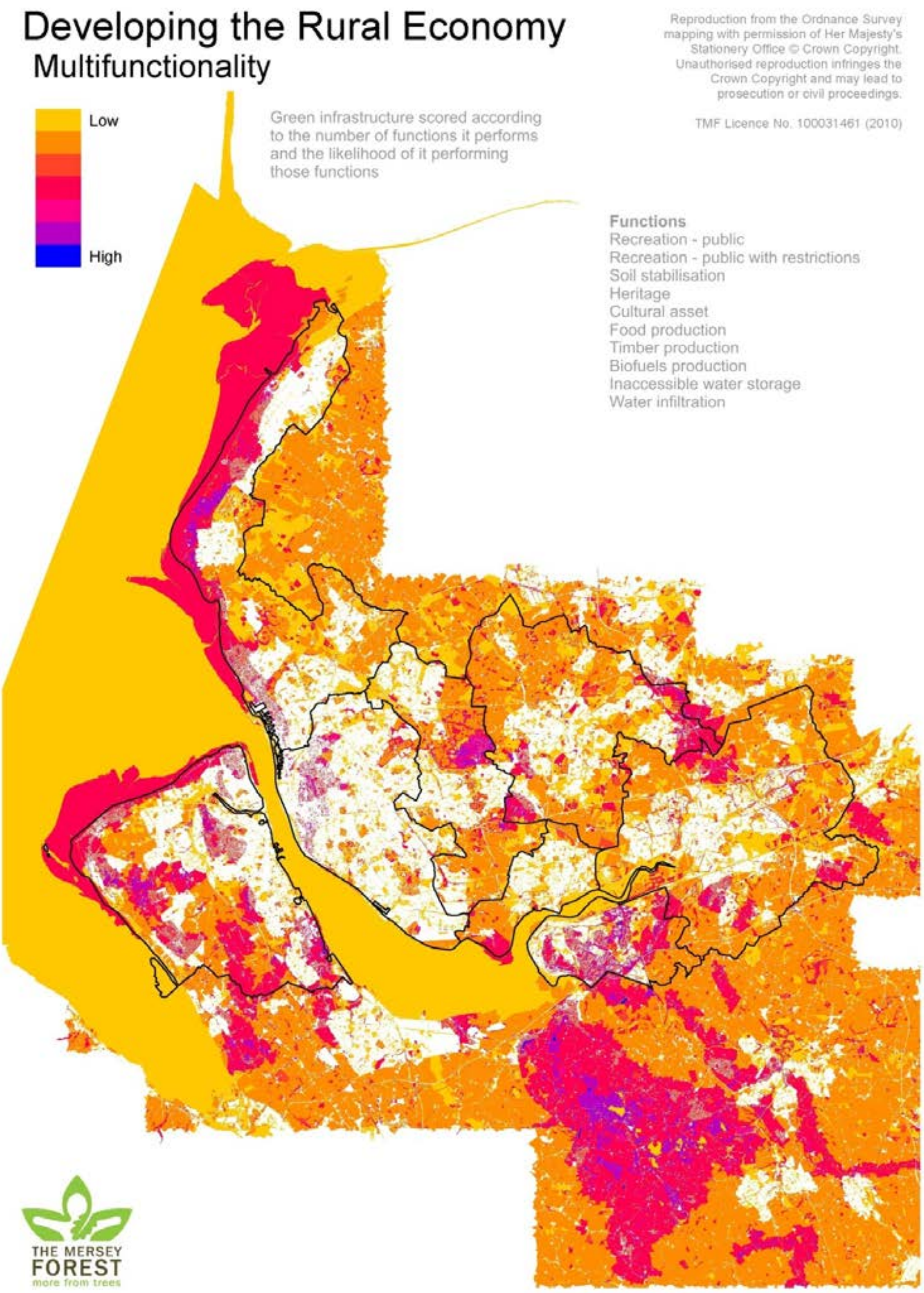
The large number of functions associated with this priority is due mainly to the fact that there are five functions related to water management issues.

Areas that performs a high number of functions with regard to adaptation to climate change include Sefton Coast and Pinewoods; Knowsley Estate; Parkside; the green corridors across Runcorn; Prescot, Whiston, Rainhill areas of St.Helens, around Newton Le Willows and West Wirral, in particular: Thurstaton, Arrowe Country Park, Neston and The River Mersey.

The city and town centres again show low functionality as do areas both immediately north and south of The Mersey. Knowsley Industrial Park also stands out as an area of low functionality for this priority.

Developing the Rural Economy

Ten functions are used to assess this priority.



Map 19 Supporting Adaptation to Climate Change Multi-functionality across the Liverpool City Region

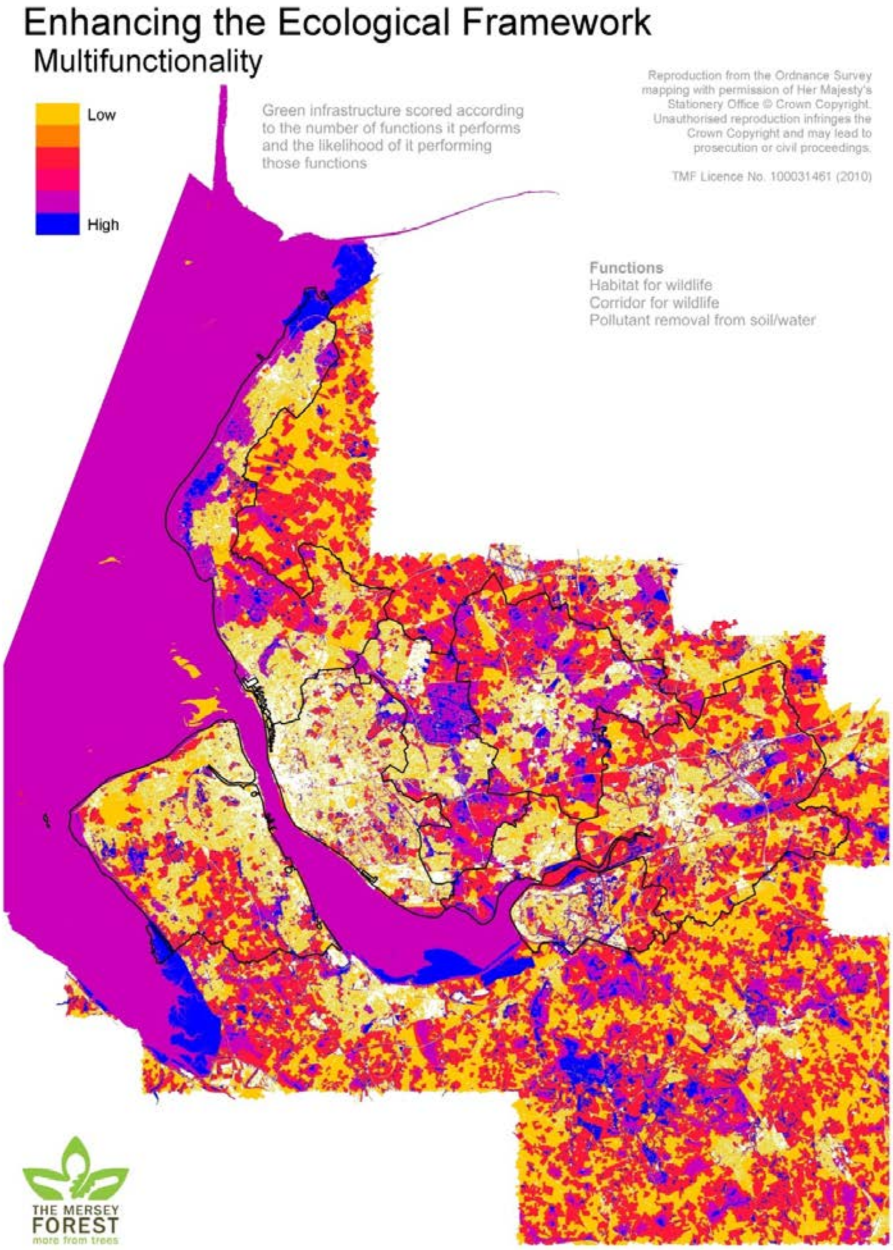
it is clear to see that the following areas of the city region have a high number of functions that support the rural economy: Sefton Coast Woodlands; Knowsley Estate; Hale; Newton Le Willows area; Blundells Hill, north Warrington and east St.Helens; the green corridors across Runcorn, Hale; and Caldy/Thurstaston areas of Wirral.

Within the rural area the areas that display low functionality tend to be fairly small and discrete. For example, some areas of mossland farming in Sefton.

The data in has been clipped to show only those areas that are considered rural in the "Green Zone 2025" strategy (see page25)

Enhancing the Ecological Framework

Three functions are used to assess this priority.



Map 20 Enhancing the Ecological Framework Multi-functionality across the Liverpool City Region

The following areas perform a high number of functions to enhance the ecological network: Sefton Coast Woodlands/Dunes; Knowsley Estate; the rural areas of St.Helens in radial spokes from the town centre; M57 around Cronton and the Mersey/Dee estuaries. The Mersey east and west Warrington Town centre shows high functionality as do the mosslands.

There appears to be high level of functionality around the outskirts of Knowsley and St.Helens and again the Mersey provides a highly functional area. The functionality around the outskirts of Liverpool is less consistent. West Wirral has high, but not continuous levels of functionality for this priority.

In general towns and cities show less functionality, but the importance of green wedges such as those in Liverpool City for the ecological framework is clear to see from the mapping.

Identifying needs

From the data and analysis described in the preceding sections, the spatial distribution of functions that can assist in delivering the six city region priorities have been identified and mapped.

However, key to developing recommendations and actions for this Framework is an understanding of how this functionality addresses the needs of the city region. For the city region and Warrington we are most interested in the areas of greatest need; areas that stand out at a city region level as being important.

The "greatest needs mapping" uses a wide range of datasets to look at each of the GI functions.

This analysis is independent of the amount of green infrastructure in an area. The questions being asked are based on the 28 GI functions, for example.

- *"Where is the greatest need for carbon storage?"*
- *"Where is the greatest need for water infiltration?"*

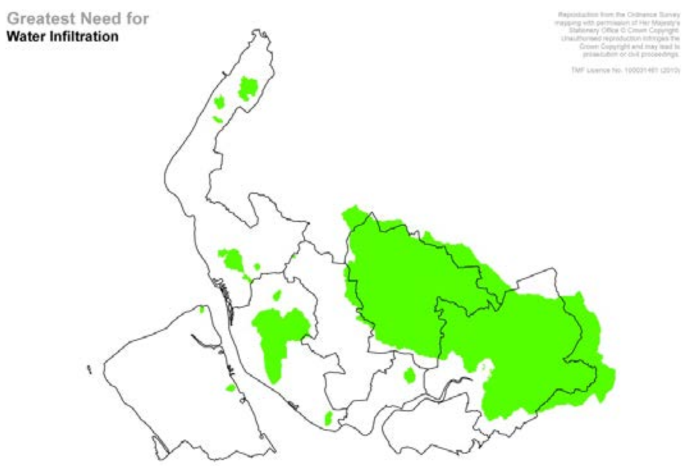
The maps for all 28 functions that are derived from the data gathered to answer these questions are provided in Appendix1.

Appendix 1 also provides details of the datasets that have been used to try to answer the question for each function and importantly the rationale for the identifying "greatest" need for each function is provided.

There is no official threshold for "greatest need" and so we have used judgement and feedback from stakeholders along with "sense testing" to establish arbitrary but meaningful thresholds above which we identify "greatest need" across the city region and Warrington.

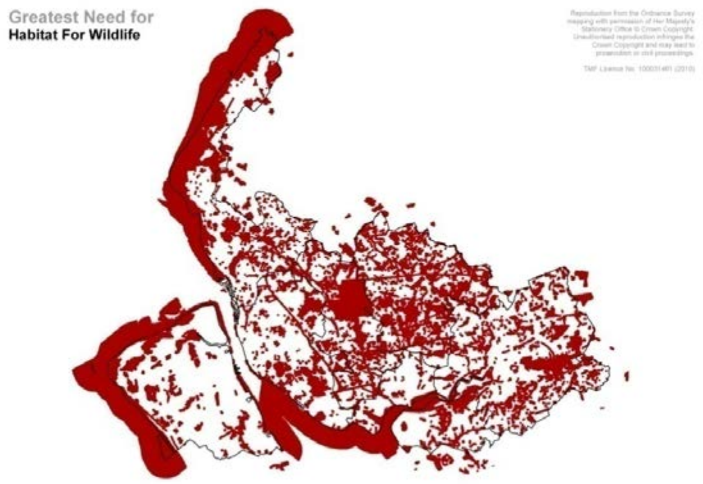
Some examples of the greatest needs maps are provided below.

Map21 Greatest need for water infiltration



The greatest need for water infiltration are areas identified as being within the catchment of recorded flood events, data provided by the Environment Agency. Getting water into the ground through infiltration (particularly on porous soils) can help to reduce the effects of heavy rainfall. However it should be noted that this function can only be provided whilst the soil is not at field capacity and is able to infiltrate through the soil profile to ground water and/or water courses.

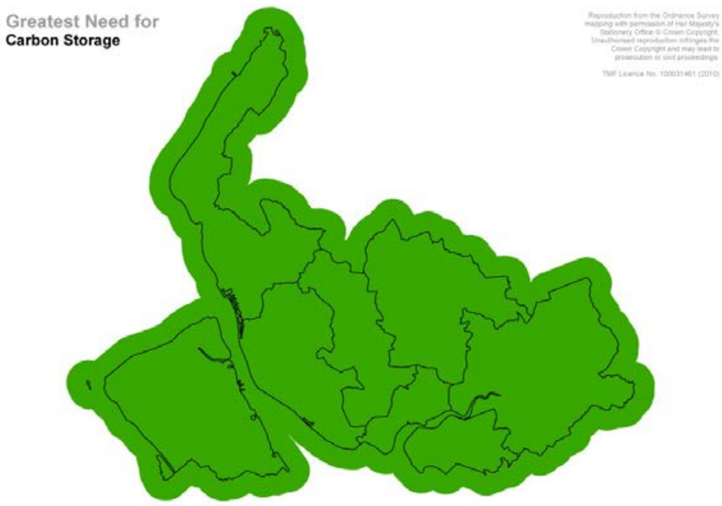
Map 22 Greatest need for habitat for wildlife



The areas of greatest need for habitat are based on the Ecological Network key habitat sites across the city region, with the same methodology applied to Warrington.

Map 23 Greatest need for Carbon Storage is a different from most of the other greatest needs maps in that the whole area is seen as being of greatest need indicating that there are no local factors affecting this need.

Map 23 Greatest need for carbon storage



From these maps it is possible to create an overall multiple need maps and individual multiple need map for each of the six priorities for the city region and Warrington.

Bringing together function and needs

Bringing togther the functionality and greatest needs datasets allows us to create two new maps for the city region and Warrington.

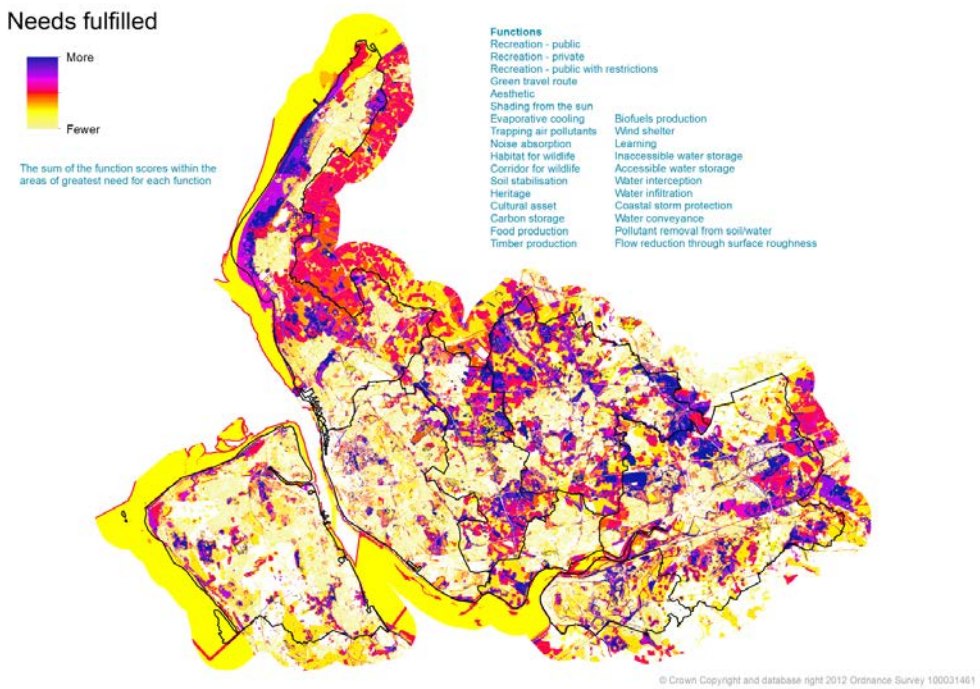
Firstly we create a map that shows where current GI functionality exists in an area of need. We call this a map of "Needs Met"

For example, where we have shown that the water infiltration function is being provide for instance by a woodland or wetland area AND other non GI datasets have shown that this area can also be described as being an area of greatest need for water infiltration then we indicate that this need is being met.

Further examples are where a need for public recreation has been identified and there is a public park nearby, or where an area of mossland is fulfilling the need for water storage or where trees are located in an area with high levels of air pollution and can act to absorb some of the particulate and gaseous pollution.

Repeating this comparison for all 28 functions allows us to create Map 24. The map shows a gradation from low to high, representing the number of "**needs met**" across the GI Framework area. High values indicate that the GI in that area is meeting a large number of the greatest needs identified in that area. GI in purple areas is likely to be meeting three or more needs. "Low" indicates that fewer of the identified needs are being met through GI functionality.

Map 24Extent to which needs are met in the city region and Warrington



The Sefton Coast, the areas alongside the M57, agricultural areas to the north of St Helens and the woodland areas in Sefton and Halton along with the major parks and areas along the escarpment and west Wirral all show higher relative number of needs being met by green infrastructure.

The following are worth highlighting as areas where there are higher levels of need met:

- Sefton coast woodlands
- Leeds/Liverpool canal corridor
- West Park/Eccleston area of St.Helens
- Newton Greenway and Haydock Park Race course and woods at Haydock Farm
- Eastern side of Knowsley estate
- Town Lane
- Green corridors particularly in Birchwood and Runcorn (New Towns)
- M57 Road corridor, Knowsley

In contrast to these areas, the towns and cities show lower levels of need met and there is generally considerable potential to improve functionality through green infrastructure planning.

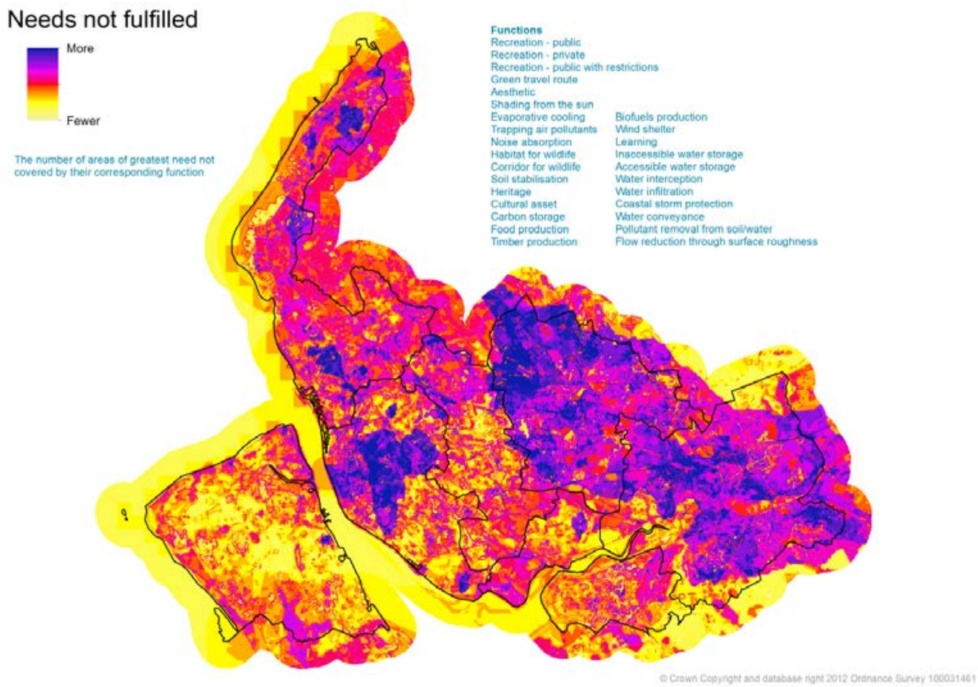
The areas of higher needs met tend to be localised with no great spatial extent.

In a similar way we are able to map the areas where greatest need has been identified but where GI is not providing the functionality to meet that need. For example, no water storage green infrastructure functionality in area of flood risk, or green infrastructure with no air pollutant trapping function (amenity grass for instance) in an area of high pollution levels.

We term this "**needs not met**". This could be simply becasue there is no GI in that area or that the type of GI does not deliver all of the functions needed. For the latter case it may well be that change in management could increase function, or it may mean that consideration could be given to changing the GI type to provide the functionality required.

Note that it is possible to have a high number of needs met and a high number of needs not met in the same location, if the total number of needs in that location is very high. Some of them may be met by the green infrastructure there and others not. This means that a location may appear in a relatively dark colour on both maps.

Map 25 shows a gradation in the level of needs not fulfilled with "high" indicating that that there are a greater number of need unfulfiled than "low". Central Liverpool and parts of urban St.Helens, South Sefton and Warrington stand out. The other main concentration is North West St.Helens including the Rainford Bypass and agricultural areas west of Windle Island.



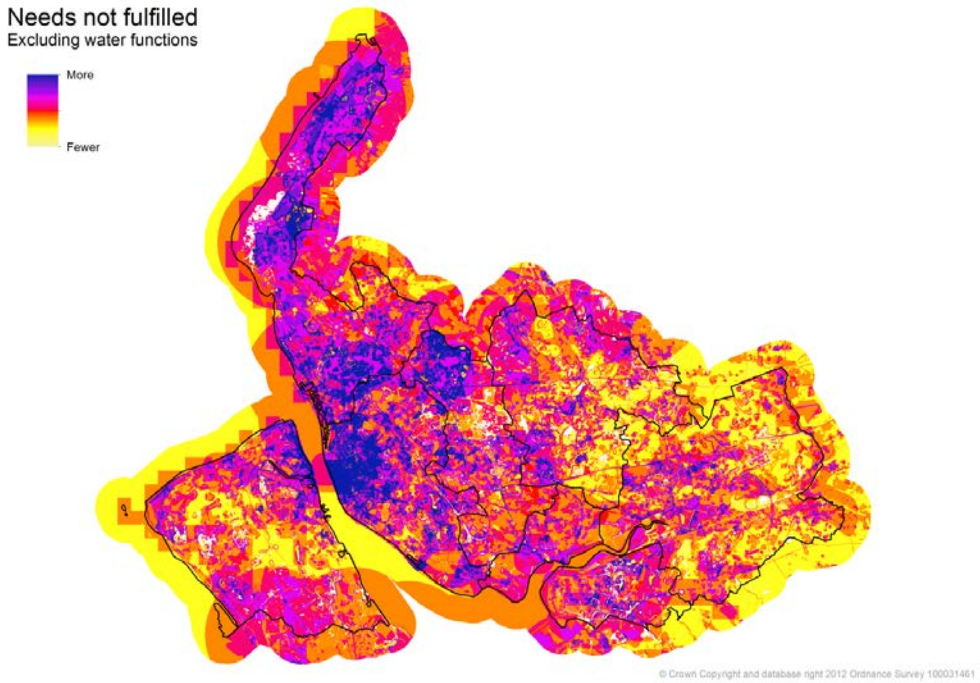
Map 25 Needs not fulfilled across the Liverpool City Region

Map 25 also shows a concentration of needs not met for the water management functions in St.Helens and Warrington. This may indicate that the water functions are over emphasised, or at least that they can mask other important areas of needs not fulfilled.

As water management is such a key issue for the city region and Warrington, and has a strong policy driver through the Water Framework Directive, the areas of high levels of need not met shown in Map become key areas for investigation.

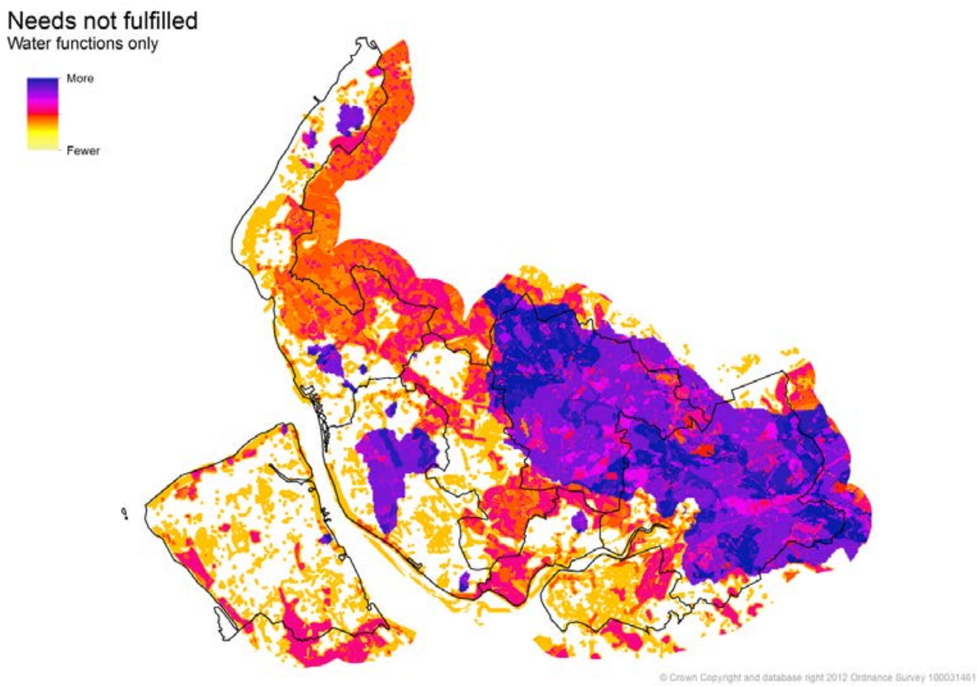
Map 26 shows the needs not met excluding the water functions Map 27shows the data for the water function only.

Map 26 Needs not fulfilled - excluding water functions



Without the 5 water functions there is a different picture for the city region and Warrington with high levels of need not met along the north east of the city region, to the north of Knowsley and along the Mersey as it runs through central Warrington and Halton.

Map 27 Needs not met - Water Functions only



Looking at only the needs not met for the water functions only we can see two very clear area of need not met across Warrington and St Helens and also through the centre of Liverpool. The need for water management function is based historic flooding events. For example in Warrington and St Helens the events of;

- December 1978
- February 1990
- June, October and November 2000
- April and May 2001

Needs Met and Not Met for each function

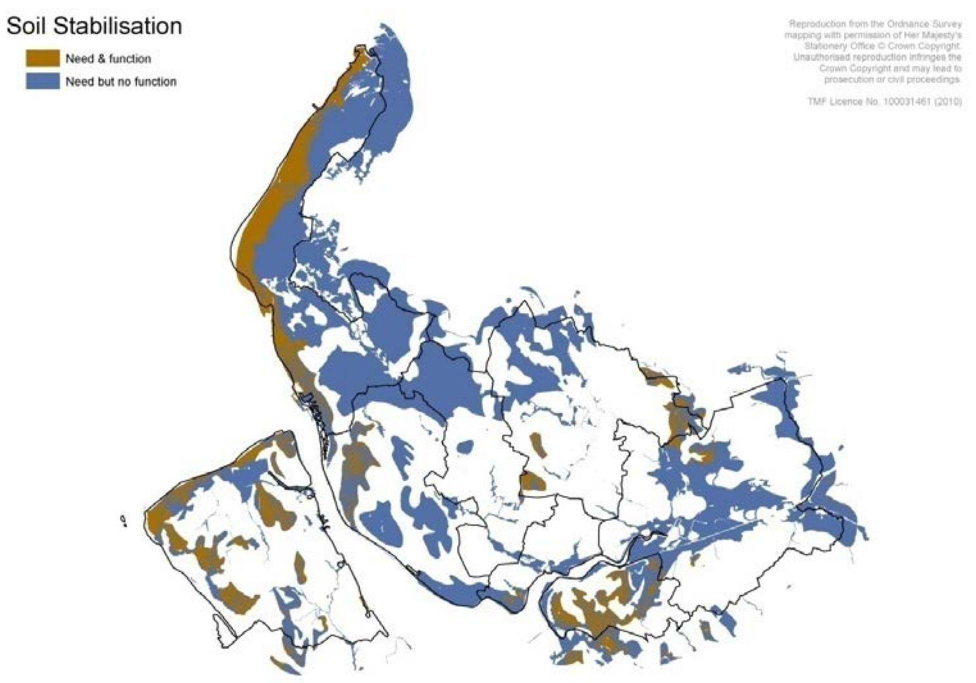
From the data gathered for this Framework we are also able to produce a “needs met” and “needs not met” map for each of the 28 GI functions that have been assessed. Each of these maps identifies

- Places with both need and GI function
- Identified need but no appropriate GI function

The complete set of these maps is provided in Appendix 1. Three examples are shown below.

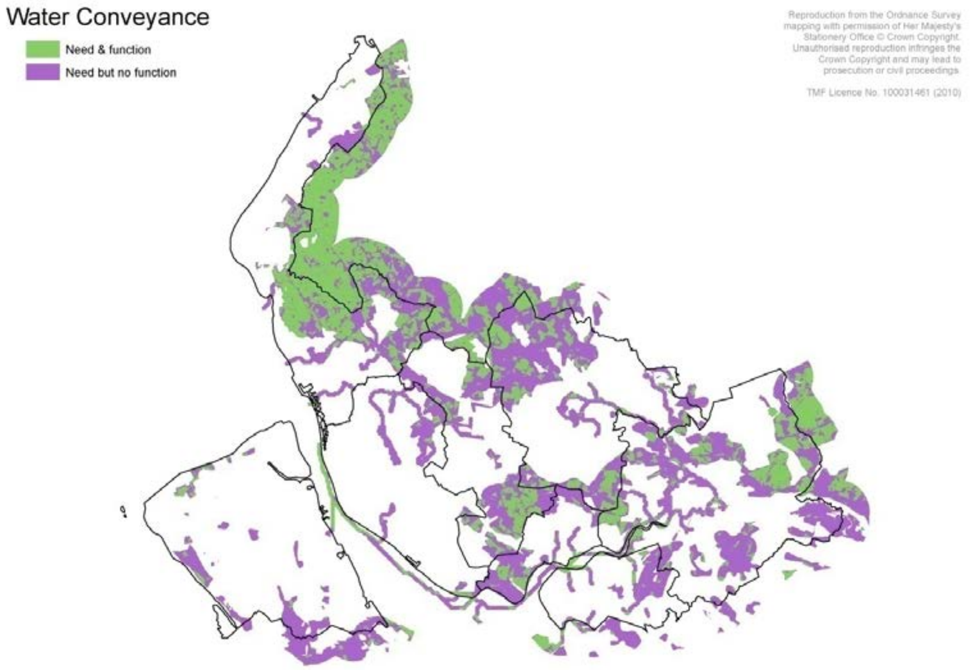
Map 28 shows a need to improve soil stabilisation across large areas of the north of the city region and the ribbon of moss land farming along the eastern boundary of Warrington.

Map 28 Soil Stabilisation - need and function



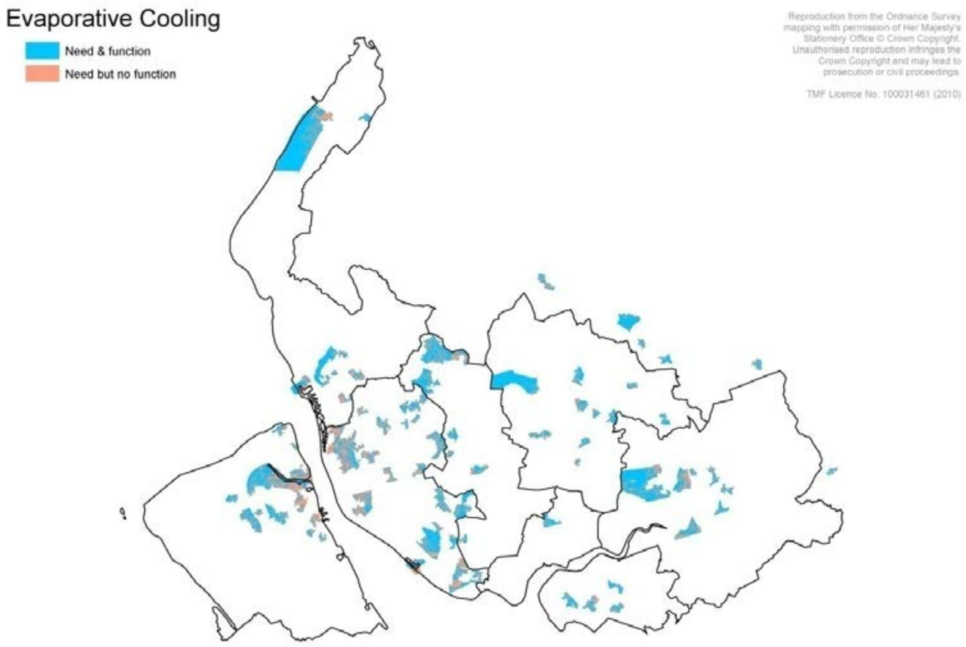
Map 29 indicates that whilst there are large areas where increased functionality to enable water conveyance would be beneficial, there are also large areas where already large areas where GI is performing this function and helping to reduce risk of flood.

Map 29 Assessment of green infrastructure function against need for water conveyance - important for flood risk reduction



It is a similar picture with Evaporative Cooling (Map 30); where there are important areas of GI delivering this function in areas of greatest need.

Map 30 Evaporative cooling



These maps provide useful evidence to help inform specific actions and investment at the city region and Warrington level. For example helping to identify where soil protection measures may be best put in place or where there is a need to increase green cover to help reduce the impacts of a heat wave on vulnerable communities or key visitor destinations.

Applying this approach to areas of future investment -Assets and Pinch Points

For areas of projected future investment we can use the data from the preceding section to identify:

Assets – In this framework, the term “asset” has been used to describe green infrastructure that is delivering a function or functions in an area of identified need. For example, woodland that is intercepting and storing water in an area of flood risk is a water management asset; it is providing functions that help to reduce the risk of flooding.

Pinch Points - Pinch Points are identified as areas where a "need" has been identified, for which green infrastructure functionality could provide a solution, but where that functionality is not provided at the moment AND that pinch may prevent planned investment from taking place or reduce its return or likelihood of success or add significant cost to the investment.

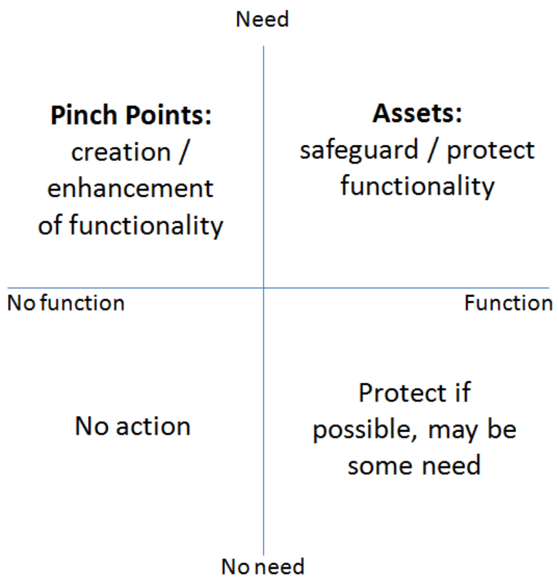


Figure 41 Assets and Pinch Points

The lack of functionality may be because there is no green infrastructure or perhaps because the existing type of green infrastructure does not provide the functionality that is needed.

For example, in an area of high flood risk a lack of water management functionality creates a pinch point. Future growth, existing quality of life and a range of other issues are adversely affected by these pinch points. They act as constraints.

The options available to tackle pinch points include changing the existing green infrastructure typology so as to provide the necessary functionality or where this is not possible to create additional green infrastructure where resources, space and tenure allow.

For example, options for incorporating green infrastructure to intercept and store water locally and upstream of the flood area can help to mitigate flood risk.

Pinch points are closely related to the idea of environmental limits and actions to improve functionality in an area of need can both directly address "pinch point" issues and also create headroom within the environmental limit, providing capacity for future sustainable development. This is also in line with the “Nature at Work” scenario outlined the National Ecosystem Assessment, discussed in section 10.

Investment in regeneration or major housing or business development that does not take into account the impacts of pinch points will be more likely to underperform.

It is also important to recognise and highlight the GI assets; these already meet existing and projected future needs. Safeguarding these functions helps to reduce the risk of future problems in an area where investment is targeted.

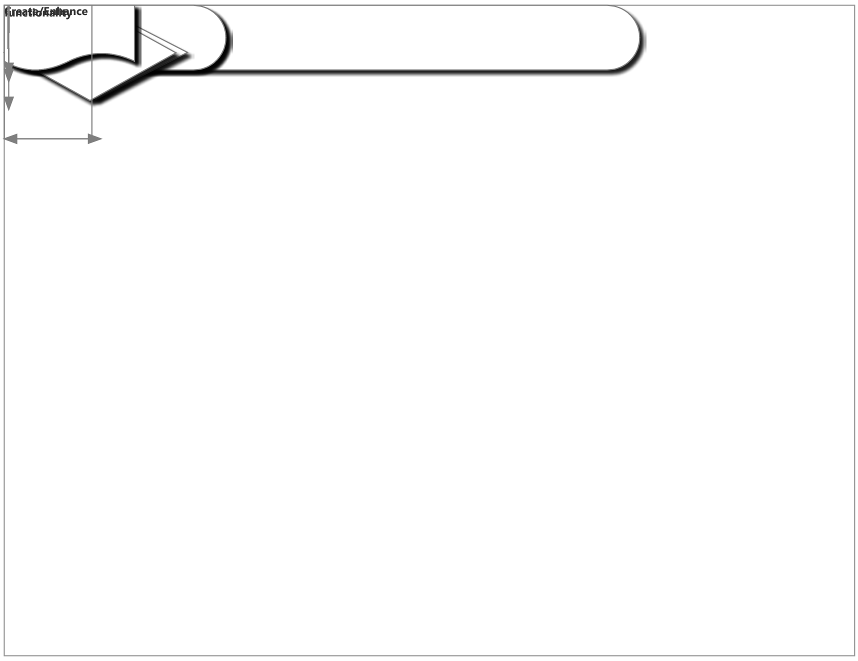
Application to Liverpool City Region and Warrington priorities

We have adapted this approach, looking at target areas for investment or improvement at a city region level and applied the assets and pinch point model to the six priorities for the Liverpool City Region GI Framework.

For each of the six priorities identified and agreed by partners projected investment or strategic priority areas have been identified from city region strategy and policy documents (see section 10).

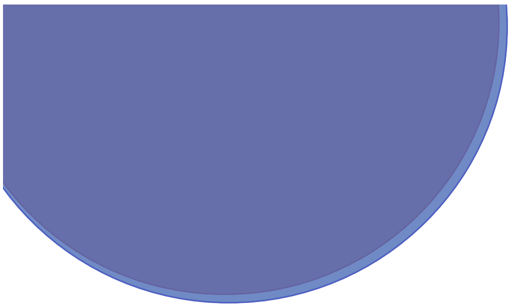
These are the areas of search.

The needs met and needs not met data is then mapped in these areas of search. From this we can identify strategic pinch points and assets. We use the term “strategic” to highlight that these are pinch points or assets that are in key investment/priority areas at the city region and Warrington level. Pinch points and assets could also be identified at a lower spatial scale in other GI strategies using the same type of approach.



The purpose of this assessment is to indicate how future GI investment can aligned with the strategic issues of the six priorities to both improve the functionality of the GI and also to support sustainable development whether that is for economic investment or for health improvement etc.

Figure 42 Relationship between needs, function and projected investment/strategic priorities to create assets or pinch points.



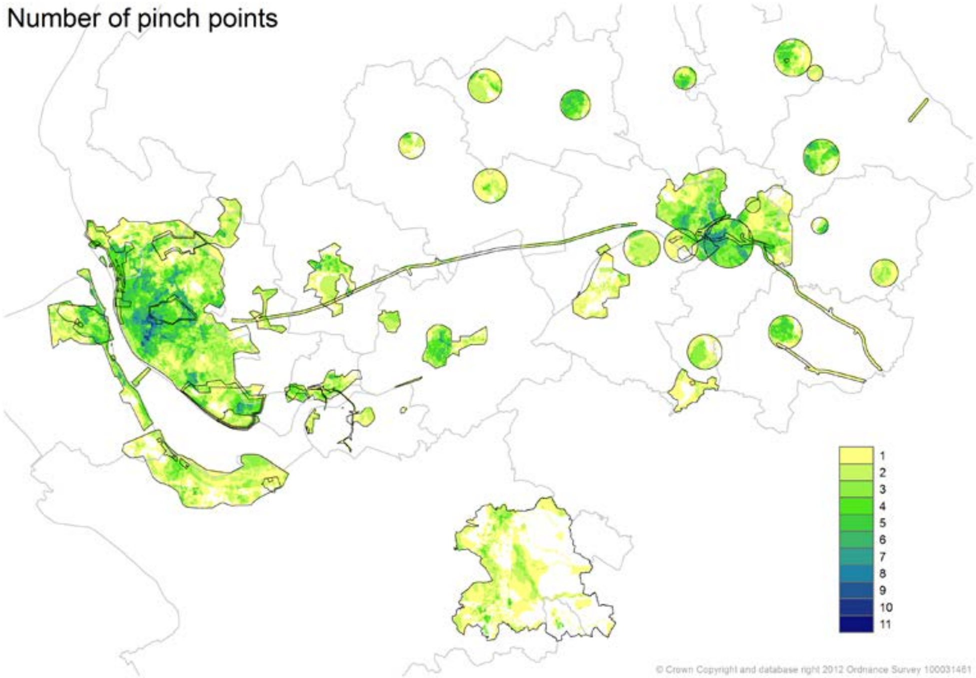
Green Infrastructure planning and effective delivery can help to underpin and add value to the city region and Warrington strategic investment priorities and assist in delivering the aspirations for Atlantic Gateway.

Using the "Pinch Point" approach we have assessed the needs not met in the areas that are strategic economic priorities. The area of search is the same as Figure 8

Map 31 shows the number of pinches in the areas of planned investment across the whole of the Atlantic Gateway area, with darker colours indicating a greater number of issues (pinches) to address.

Central and North Liverpool along with the central area of Warrington show the higher numbers of "pinches" that need to be addressed in order for investment to reach its full potential.

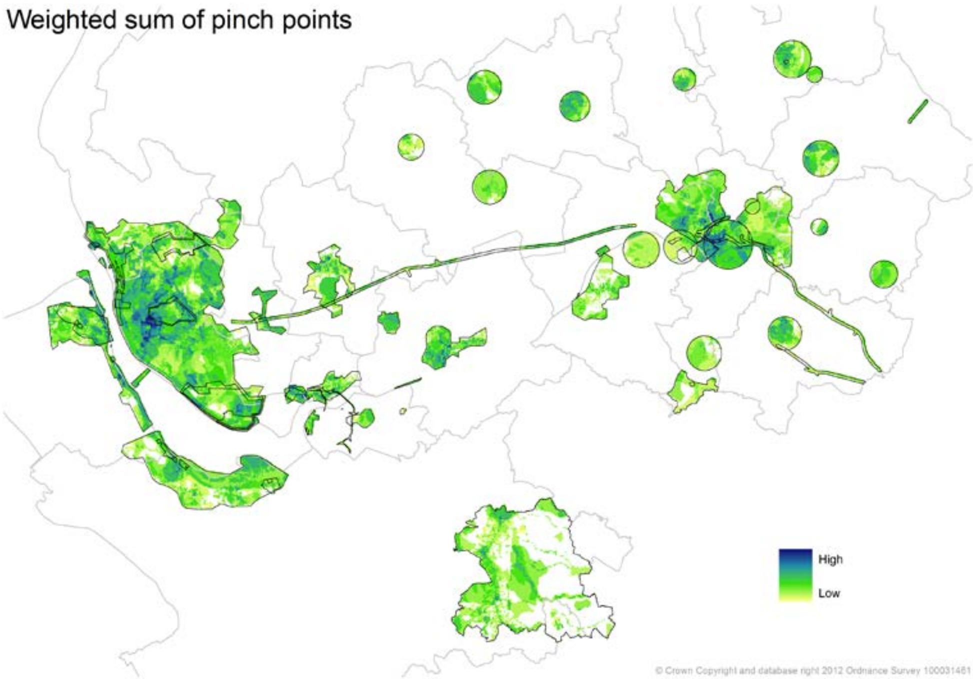
Map 31



In this assessment we also recognised that investors may "weigh" some pinches more heavily because they see them as being more important than others.

Map 32 Weighted sum of pinch points, is based on increasing the weightings given to pinches such as risk of flood and risk of poor air quality.

Map 32 Weighted sum of pinch points



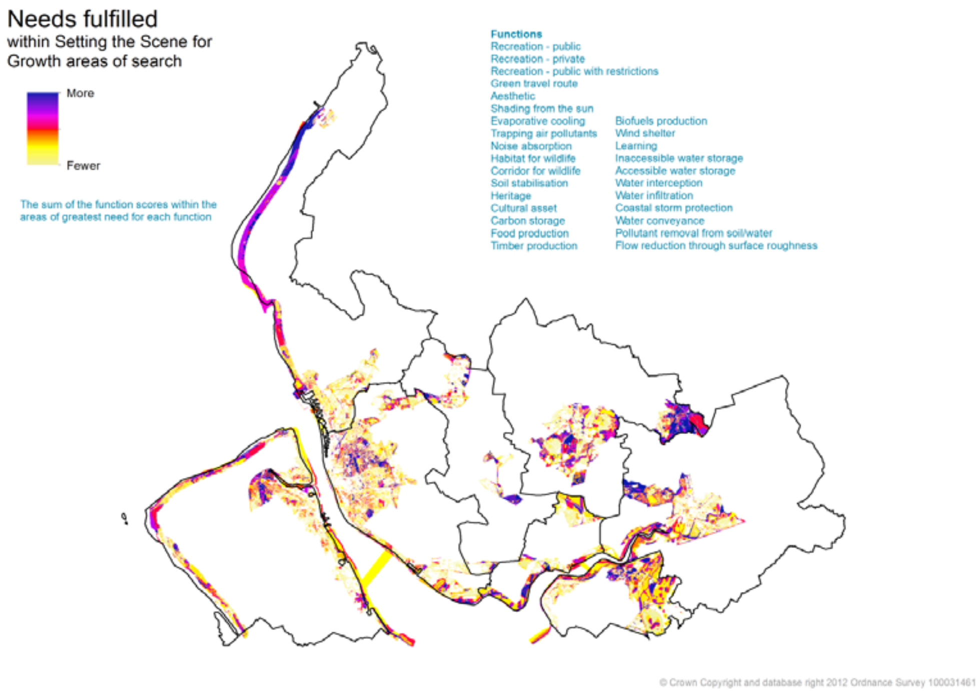
Comparing the two maps (Map 31 and Map 32) there is not a great change in the areas that stand out as having higher numbers of pinch points, but in general the maps is darker indicating that the pinches that exist across the whole area have been given a high weight, they are likely to be issues that are of most interest to investors.

Conversely looking at the assets, green infrastructure in the area of search that is meeting need, we see (Map 33) we see that there are areas with higher numbers of need met, but on the whole the higher levels are relatively small and scattered across the area of search.

The area of St Helens around Newton Le Willows shows up as being a relatively large area of GI Setting the Scene for Growth in the area of search.

In another way the Trans Pennine Trail shows up as providing a significant resource (potentially) for green travel and connecting areas or employment with areas of high unemployment.

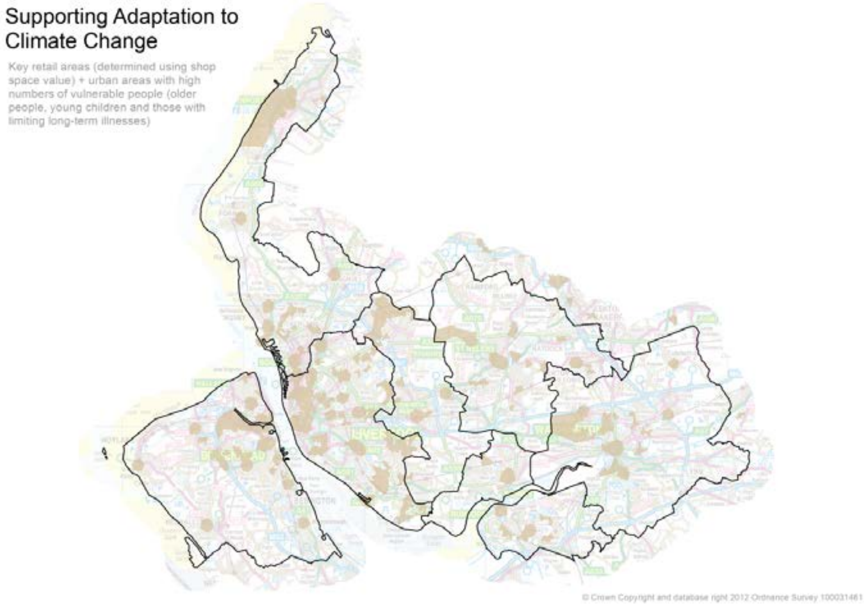
Map 33 Setting the Scene for Growth -needs met



Climate Change pinch points

Areas of the city region with a high percentage of vulnerable people (elderly, those with limiting long term diseases, young people) and the top retail areas have been identified as the places where it is useful to identify assets and pinches.

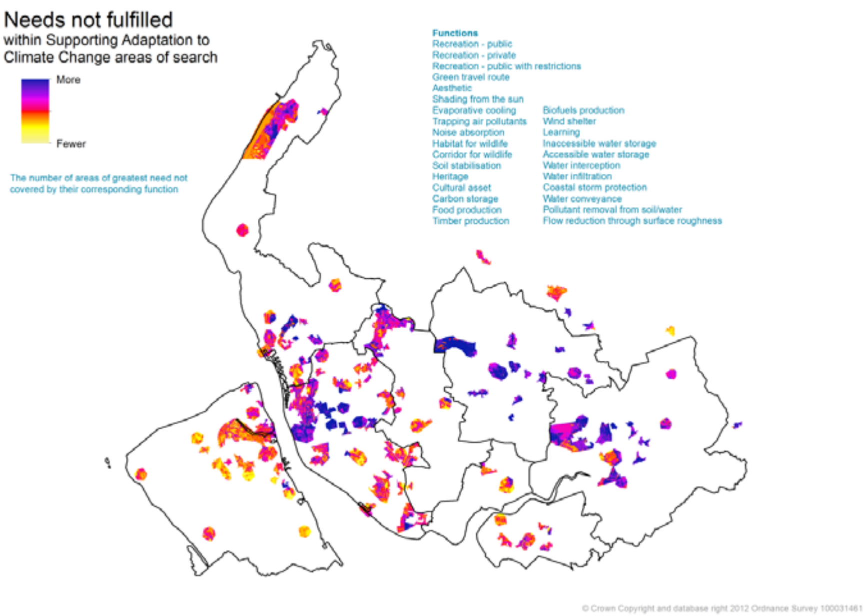
Map 34 Key areas of search for climate change pinch points



Within this search area Map 35 shows the number of needs not currently met by GI to help address climate change.

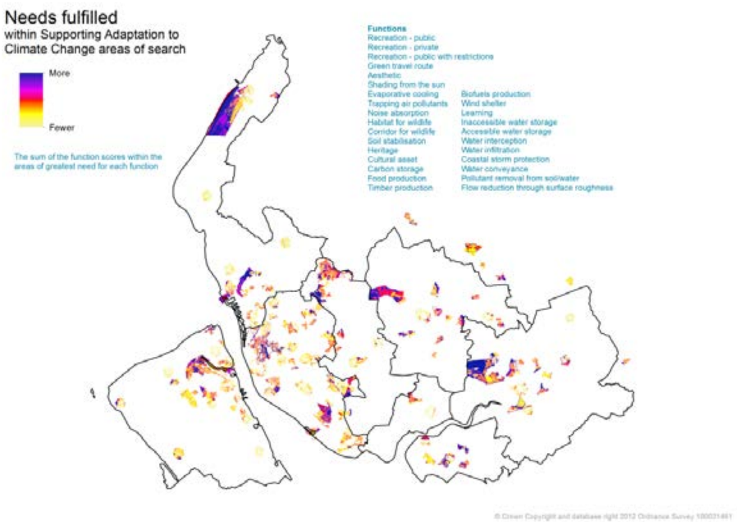
There are significant clusters around Southport, North Liverpool and South Sefton, Birkenhead, Kirkby and West Warrington.

Map 35 Needs not met within the areas of search



Sefton coast and areas on the west border of Warrington with St Helens as well as areas such as Rimrose Valley and several of the large parks in Liverpool and Wirral stand out as climate change assets (Map 36).

Map 36 Needs met for climate change



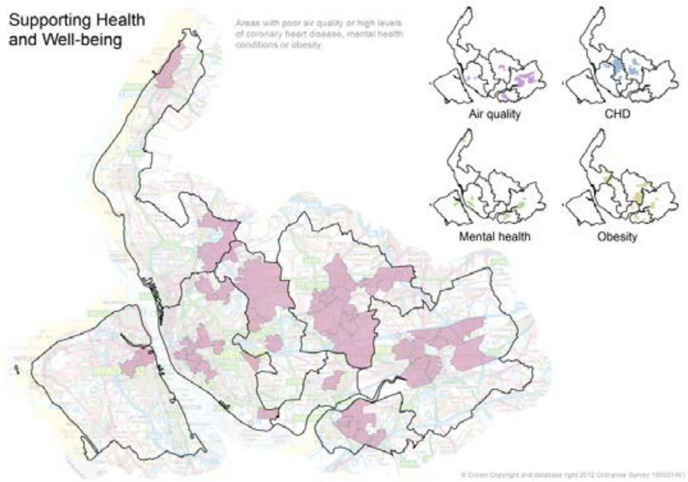
Health and Wellbeing pinch points

The areas of search for pinch points and assets for health and wellbeing have been created from four sets of data. These highlight at the city region and Warrington level

- Areas of poor air quality
- Elevated prevalence of CHD
- Poor mental health
- High levels of obesity

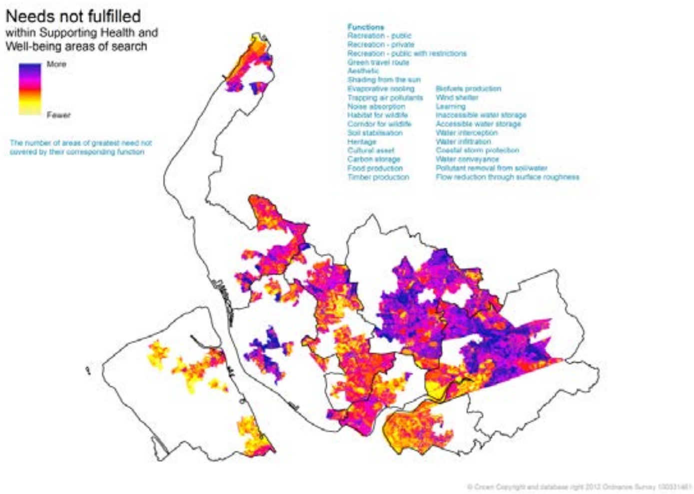
Map 37 shows the combined area of search based on these datasets.

Map 37 Key areas of search for Health and Wellbeing pinch points



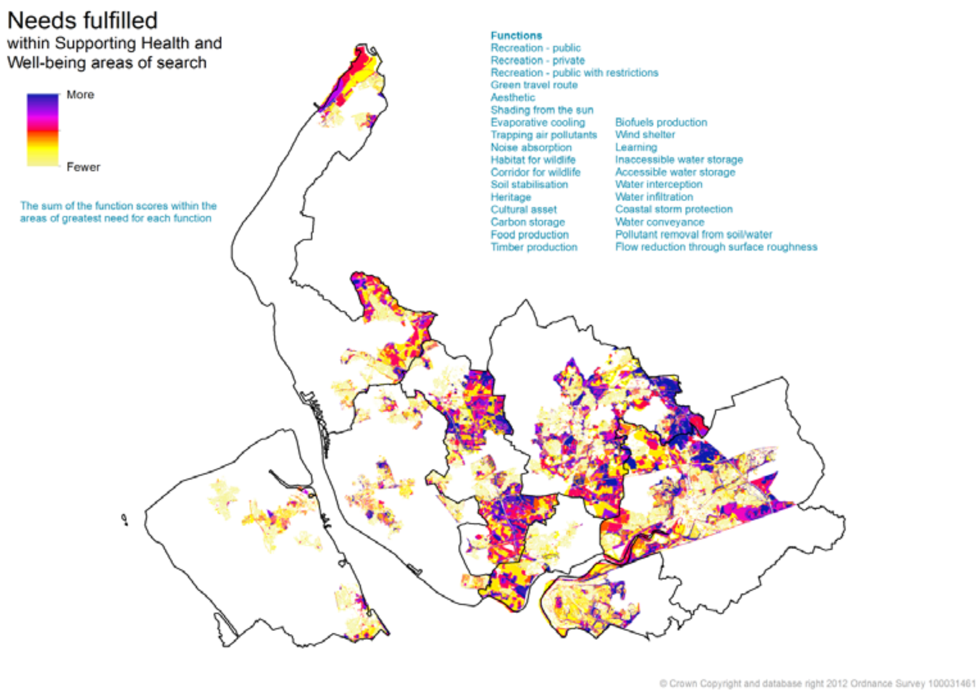
There is a significant cluster of need not met around north Warrington and St Helens, with a large swathe also running from Widnes through to Kirkby and areas of Liverpool also showing up at this City Region scale.

Map 38 Needs not met for health and wellbeing



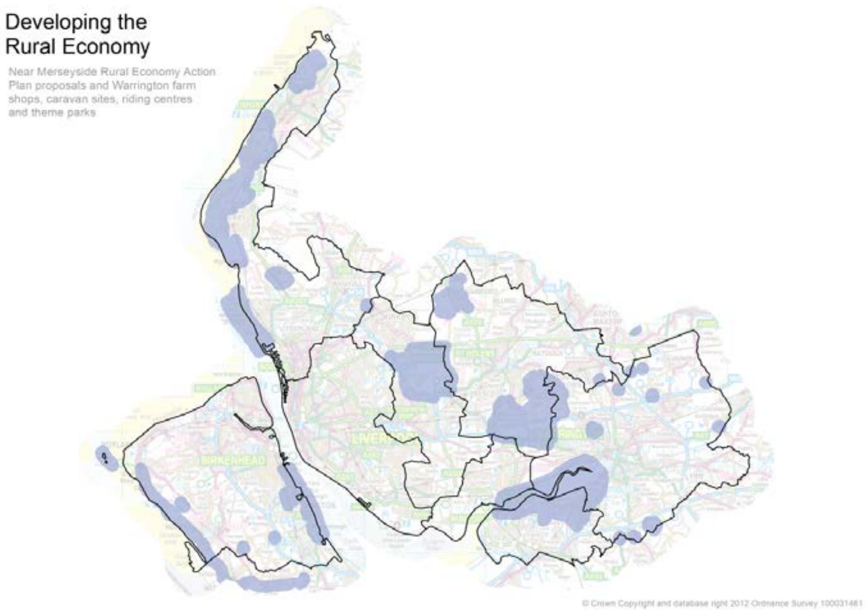
Map 39 identifies key assets around East Warrington, areas to the East of Knowsley, Sankey Valley and the Forest Parks that exist within the areas of search.

Map 39 Needs met for health and wellbeing



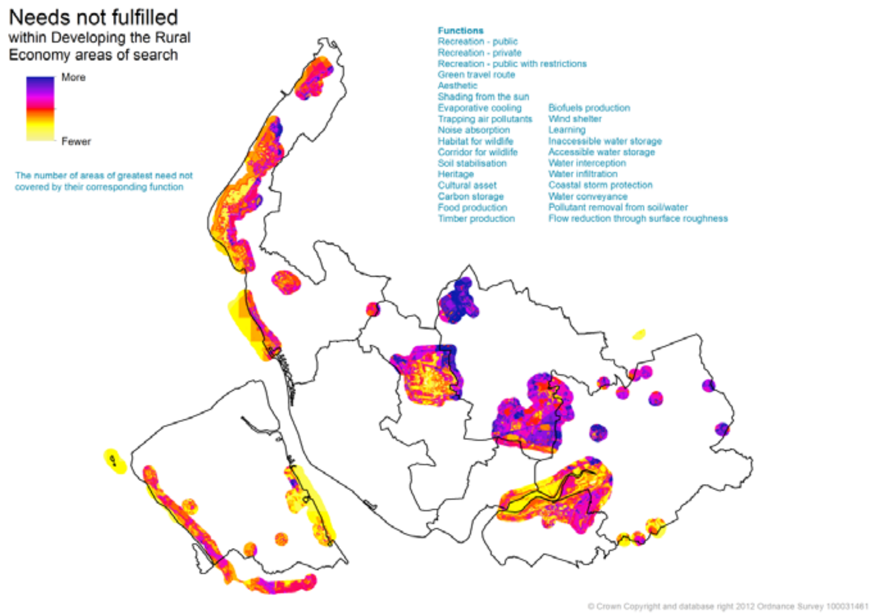
Developing the rural economy pinch points

The area of search for pinch points and assets for the rural economy has been identified using the MREAP data and a range of Warrington rural business assets.

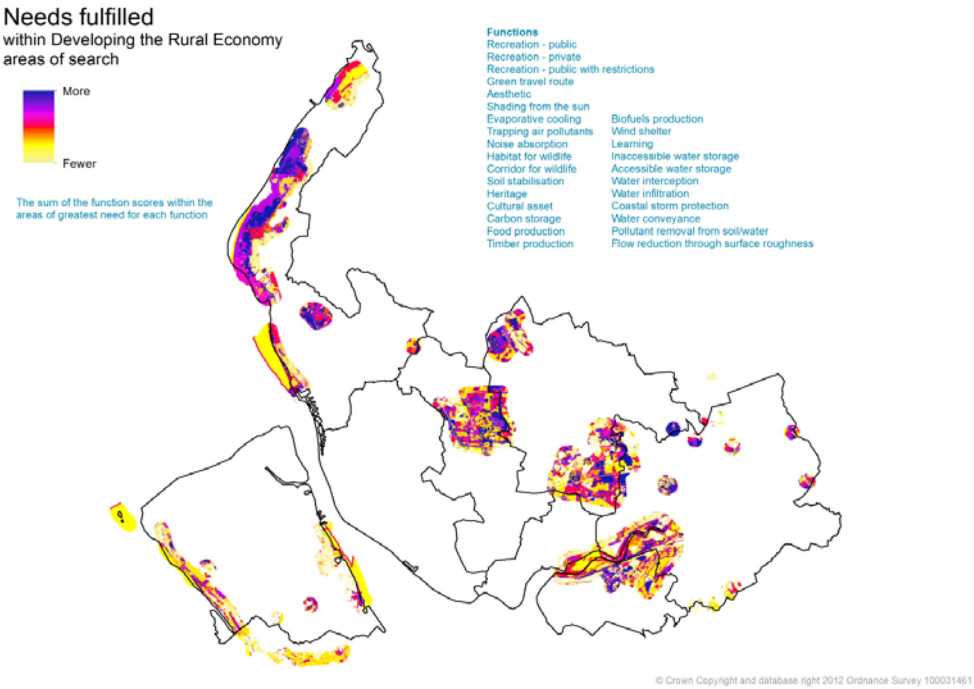


Map 40 identifies the areas in St Helens and small isolated areas in Warrington as having the greatest number of needs not met at the moment.

Map 40 Needs not met for developing the rural economy



Looking at the needs that are currently met for developing the rural economy we can see important assets along the Sefton Coast, Knowsley Park Estate and in smaller areas along the Mersey and the Warrington St Helens boundary.


Needs fulfilled
within Developing the Rural Economy
areas of search
More
Fewer
The sum of the function scores within the
areas of greatest need for each function
Functions
Recreation - public
Recreation - private
Recreation - public with restrictions
Green travel route
Aesthetic
Shading from the sun
Evaporative cooling
Trapping air pollutants
Noise absorption
Habitat for wildlife
Corridor for wildlife
Soil stabilisation
Heritage
Cultural asset
Carbon storage
Food production
Timber production
Biofuels production
Wind shelter
Learning
Inaccessible water storage
Accessible water storage
Water interception
Water infiltration
Coastal storm protection
Water conveyance
Pollutant removal from soil/water
Flow reduction through surface roughness
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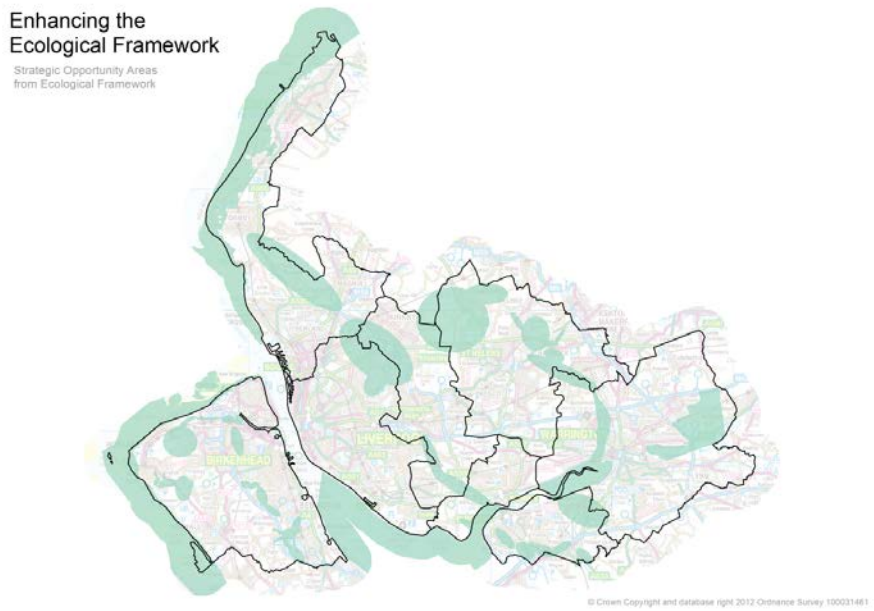
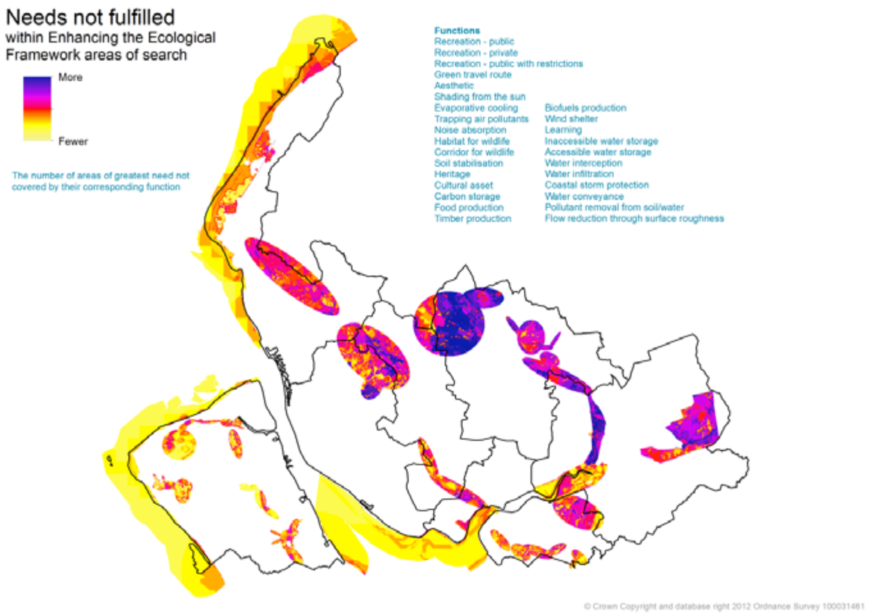
Enhancing the ecological framework pinch points

The area of search for pinch points and assets for ecological framework pinch points are defined as the core biodiversity areas and the connectivity zone as set out in the Liverpool City Region Ecological Framework.



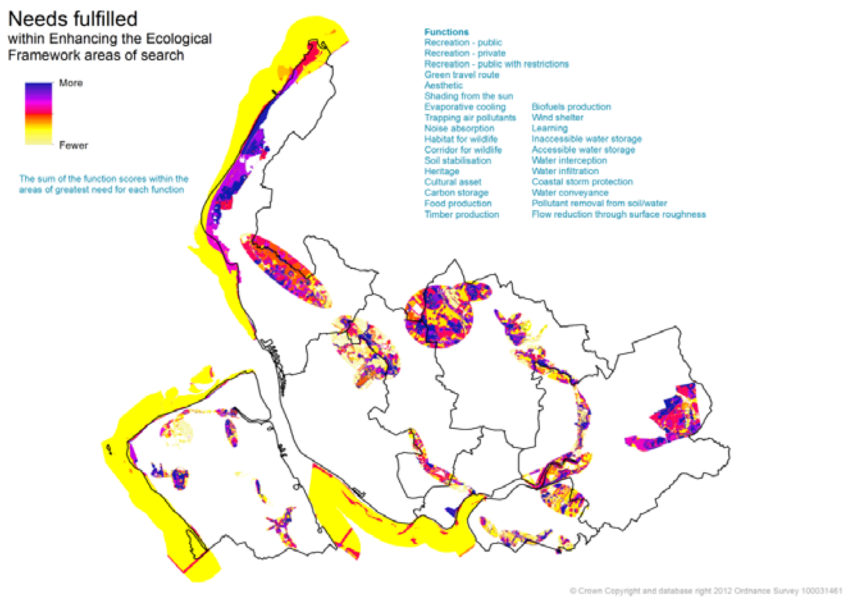
Map 41 highlights in particular North St Helens and the Sankey Valley as areas to address at this scale of planning.

Map 41 Needs not met to enhance the ecological framework



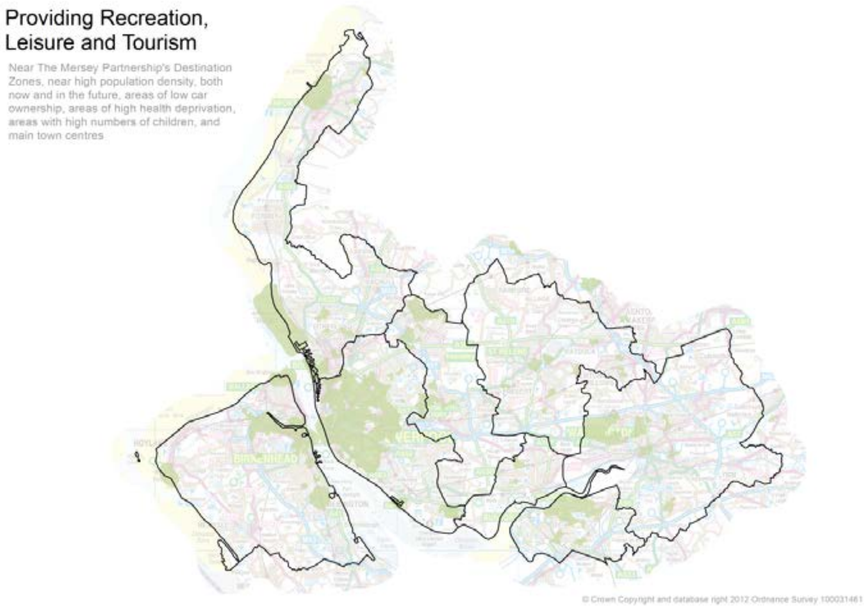
Of particular significance in terms of needs met (Map 42) is the Sefton Coast. Other areas of high levels of need met are around East Warrington and north St Helens.

Map 42 needs met within the area of search for enhancing the ecological framework



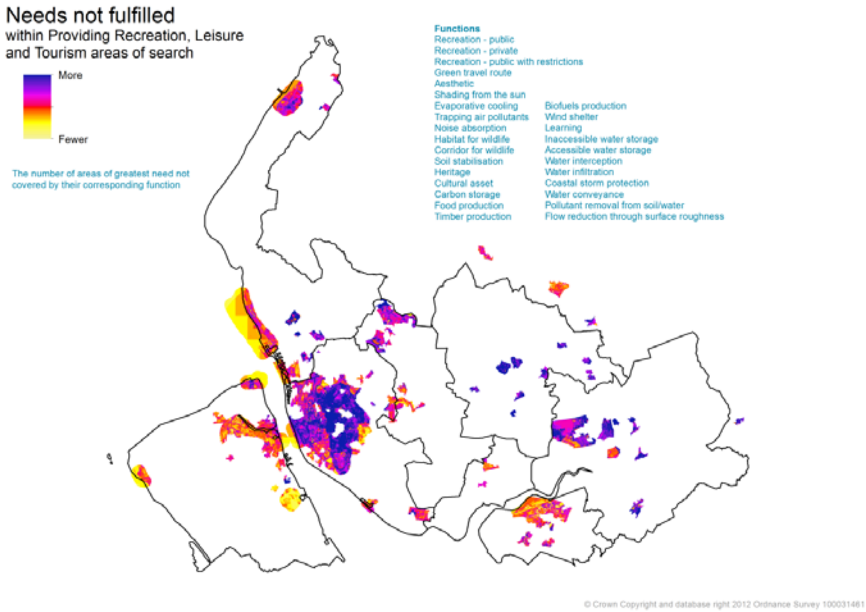
Providing recreation, leisure and tourism pinch points

The area of search for pinch points and assets for recreation leisure and tourism are based on key tourism attraction and a range of other population data. Importantly the areas also take into account projected future population growth across the city region enabling some degree of planning to accommodate the future population of the area.



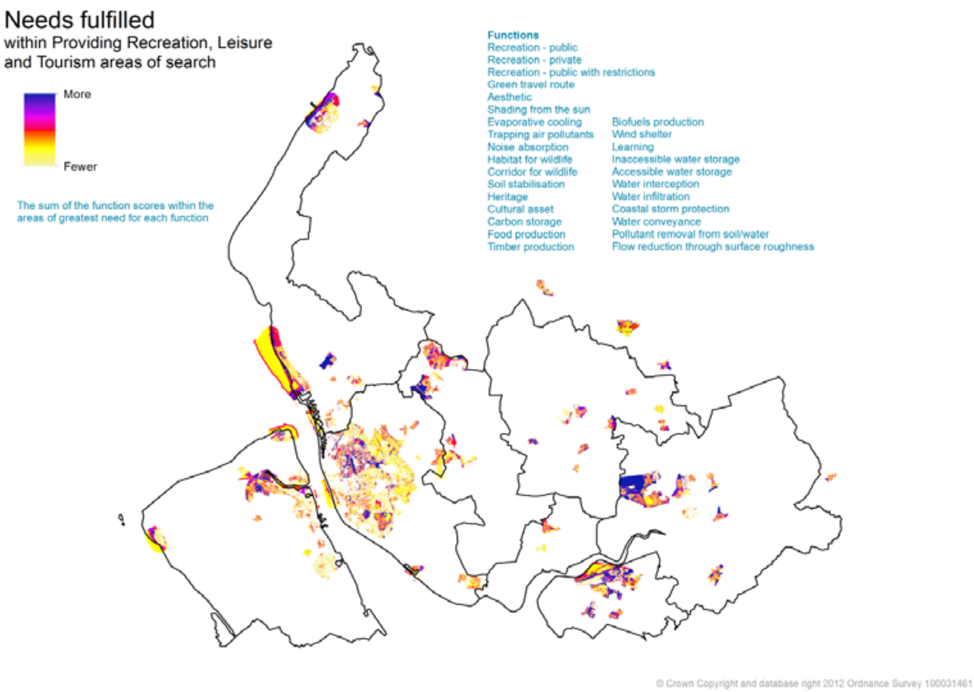
Map 43 highlights needs not met in Liverpool in particular due both the city population size and socio-economic factors and also the density of tourism attractions. At a city region level some of the need identified can be provided away from the area of need. For instance by helping to achieve ANGSt.

Map 43 needs not met for recreation, leisure and tourism

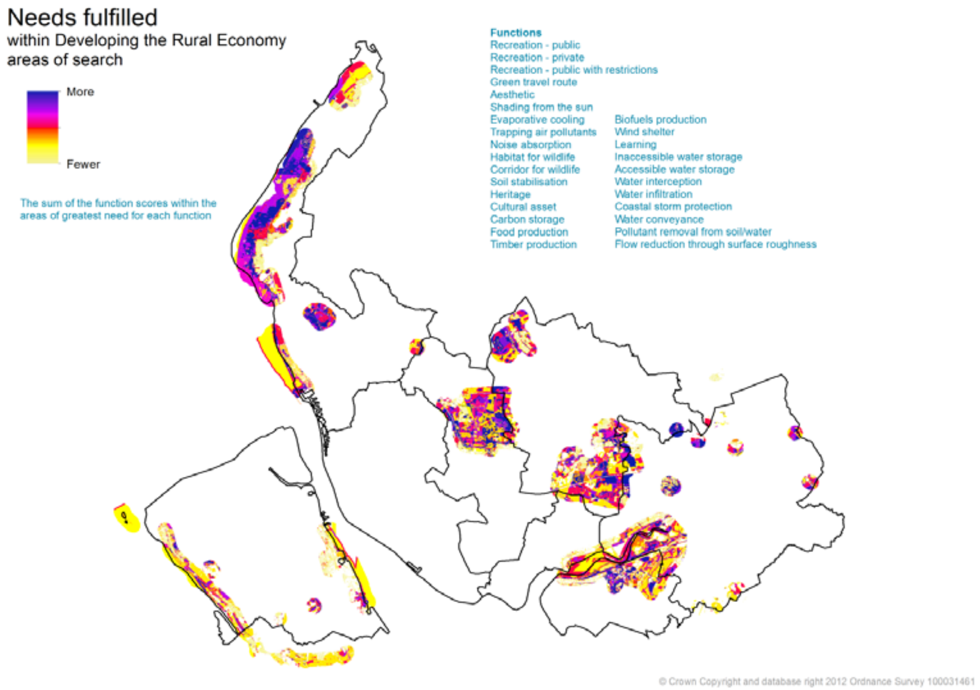


Shows the areas of need fulfilled across the city region areas of search.

Map 44 Areas of need met for recreation, leisure and tourism



Assets


Needs fulfilled
within Developing the Rural Economy areas of search
More
Fewer
The sum of the function scores within the areas of greatest need for each function
Functions
Recreation - public
Recreation - private
Recreation - public with restrictions
Green travel route
Aesthetic
Shading from the sun
Evaporative cooling
Trapping air pollutants
Noise absorption
Habitat for wildlife
Corridor for wildlife
Soil stabilisation
Heritage
Cultural asset
Carbon storage
Food production
Timber production
Biofuels production
Wind shelter
Learning
Inaccessible water storage
Accessible water storage
Water interception
Water infiltration
Coastal storm protection
Water conveyance
Pollutant removal from soil/water
Flow reduction through surface roughness
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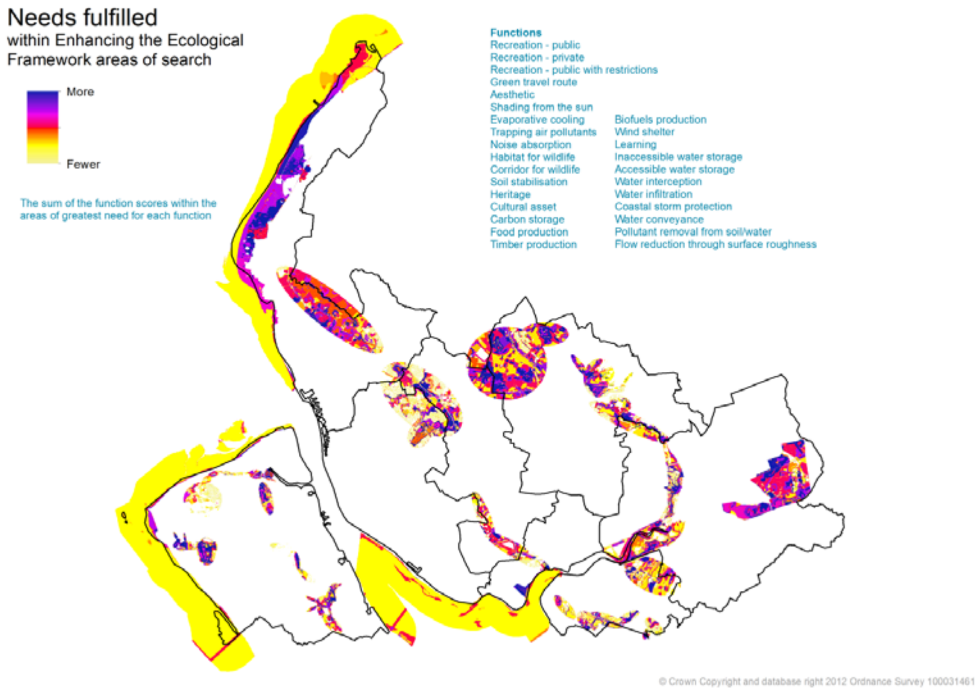
Needs fulfilled
within Enhancing the Ecological Framework areas of search
More
Fewer
The sum of the function scores within the areas of greatest need for each function
Functions
Recreation - public
Recreation - private
Recreation - public with restrictions
Green travel route
Aesthetic
Shading from the sun
Evaporative cooling
Trapping air pollutants
Noise absorption
Habitat for wildlife
Corridor for wildlife
Soil stabilisation
Heritage
Cultural asset
Carbon storage
Food production
Timber production
Biofuels production
Wind shelter
Learning
Inaccessible water storage
Accessible water storage
Water interception
Water infiltration
Coastal storm protection
Water conveyance
Pollutant removal from soil/water
Flow reduction through surface roughness
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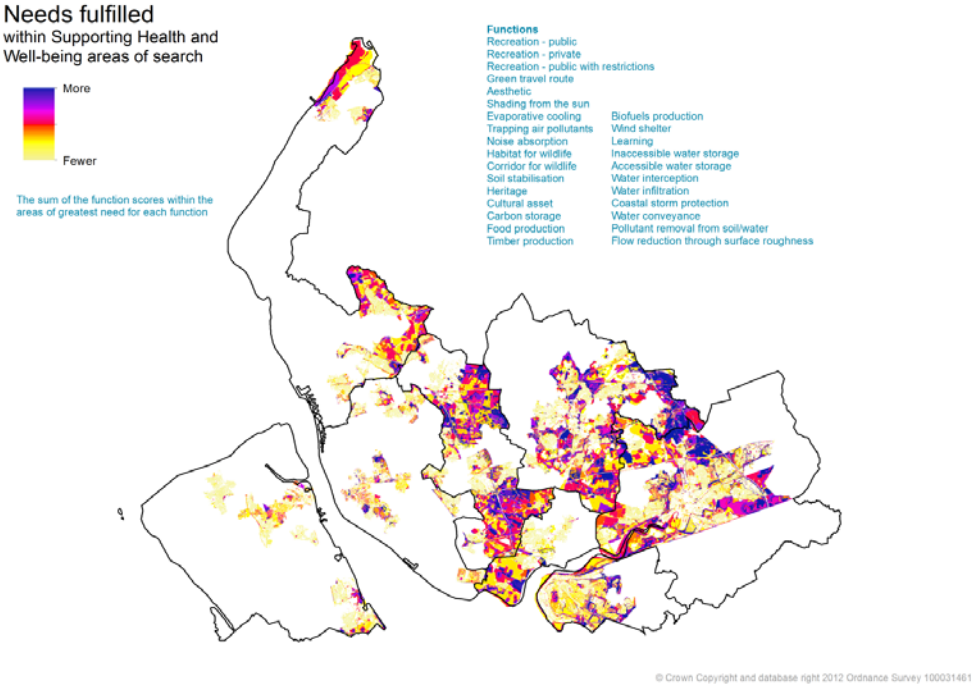

Needs fulfilled
within Supporting Health and
Well-being areas of search
More
Fewer
The sum of the function scores within the areas of greatest need for each function
Functions
Recreation - public
Recreation - private
Recreation - public with restrictions
Green travel route
Aesthetic
Shading from the sun
Evaporative cooling
Trapping air pollutants
Noise absorption
Habitat for wildlife
Corridor for wildlife
Soil stabilisation
Heritage
Cultural asset
Carbon storage
Food production
Timber production
Biofuels production
Wind shelter
Learning
Inaccessible water storage
Accessible water storage
Water interception
Water infiltration
Coastal storm protection
Water conveyance
Pollutant removal from soil/water
Flow reduction through surface roughness
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12. Step 5 – Implementation (see Action Plan Document)

Based on the previous 4 steps this section sets out to answer the questions that have been set for the GI Framework under each priority, identify a series of actions that can be taken forward at a city region and Warrington level and combine all this into summary that sets out an overall vision for GI along with medium term objectives that the actions can help to achieve.

Appendix 1 - Methodology

The majority of the mapping for this study follows a generalised methodology that has been developed by The Mersey Forest team for green infrastructure planning. This methodology has garnered significant acclaim in the region and further afield, and has been used for several previous studies, although it is always evolving. There are multiple versions, of which this is only one.

The methodology consists of four main stages:

- Typology
- Functionality
- Needs
- Needs fulfilled and not fulfilled

Typology

The first step was to classify all of the land and surface water in the city region, together with a significant buffer, as either not green infrastructure, or one of a list of green infrastructure types, which are defined below.

Agricultural land

Land managed for agriculture, including grazing lands, crop production fields and hedgerows. Potentially irregular field margin trees may be included.

Allotment, community garden or urban farm

Allotments are small plots which collectively make up a larger green space. These plots are available for members of the public to rent for the cultivation of fruit, vegetables and flowers. Community gardens and urban farms are community-managed projects ranging from wildlife gardens, to fruit and vegetable plots on housing estates, community polytunnels, to large city farms. They exist predominantly in urban areas and are often community led projects, created in response to a lack of access to green space. They combine a desire to encourage strong community relationships and an awareness of gardening and farming. Most projects provide food-growing activities, training courses, school visits, community allotments and community businesses. Dedicated orchards are classified separately.

Cemetery, churchyard or burial ground

Land used as burial grounds, including cemeteries and churchyards, usually grass covered with occasional shrubs and trees.

Coastal habitat

Beaches, sand dunes, marshes, mudflats and semi-natural open land by the coast.

Derelict land

Land which has been disturbed by previous development or land use but is now abandoned. Waste or derelict land is often re-colonised by processes of natural succession. Land is classed as derelict whist it is in the early stages of natural succession. As succession proceeds land that may be officially classified as derelict land by the local authority, will have a different green infrastructure type e.g. grassland or woodland (or will fall under non green infrastructure).

General amenity space

Usually publicly owned and managed, and always accessible for public enjoyment. Their function is usually as a green 'landscape backdrop' but their landscape value can sometimes be minimal because of poor design. They include the 'left over' green spaces within housing and other forms of development, as well as most road verges. Most commonly, but not exclusively in housing areas - including informal recreation spaces, green spaces in and around housing, and village greens.

Grassland/ heathland/ moorland or scrubland
Grassland which is not agriculturally improved. Could include established vegetation on reclaimed derelict land which is not part of a formal recreation green space. Includes downlands, commons and meadows. Also includes areas of moorland and heathland vegetation consisting mainly of ericaceous species, and including moorland grass, shrub moor, shrub heath and bracken. Likely to include some commons within urban areas. Scrubland areas predominantly consist of shrubs, with grasses and herbs also present.

Green roof
Roofs of buildings, bus shelters or any other form of construction which are partially or completely covered with vegetation. Vegetation may be sedums, plants, perennials, grasses, trees and shrubs.

Institutional grounds
Green space in the grounds of institutions such as schools, universities and colleges, hospitals and nursing homes, and associated with commercial and industrial premises. Land usually consists of expanses of grass, scattered trees, hedgerows and shrubs. Outdoor sports facilities are not included.

Orchard
Areas populated with fruit bearing trees, can be publicly or privately owned, could be for commercial selling or local community use.

Outdoor sports facility
Includes sports pitches, school and other institutional playing fields, golf courses and other outdoor activities. Usually consist of vegetated sports surface and boundary shrubbery, trees and hedges. Can be publicly or privately owned and often occur within parks.

Park or public garden
Includes urban parks, country parks and formal gardens (including ones where you may have to pay for access). Generally designed for public access and enjoyment, combining a variety of landscape and horticultural elements. Extraneous facilities for the public may be present onsite which enhance visitor attraction.

Private domestic garden
Privately owned green space within the curtilage of individual dwellings, which is generally not publicly accessible. These plots of private land vary in size but often make up a significant part of the green fabric of urban areas. Land may include trees, shrubs, grass and flowering plants.

Street trees
Generally in urban areas, a row/collection of individual trees along the side of a road. Trees will vary in size and species depending on location and size of street. Usually located on the pavement edge in tree pits, requires reasonably wide pavements. Tree pits may be planted with small flowering plants.

Water body
Expanses of open water, including large lakes, small ponds, reservoirs and harbours. The sea is also classed as a water body.

Water course
All areas of running water, including large rivers, small streams, canals and aqueducts.

Wetland

Land dominated by wet habitats, including fen, marsh, bog and wet flush vegetation. Wetland associated with the coast, such as salt marshes, is classified as coastal habitat.

Woodland

All forms of woodland including deciduous woodland (both ancient semi-natural and woodlands of more recent origin) and mixed and coniferous woodland (including plantations and shelterbelts). Includes newly planted woodland. Small clusters of trees will be classed as woodlands.

This list was developed from the Planning Policy Guidance Note 17[284] typology to cover all green infrastructure in broad, functionally distinct categories. This mapping gives a complete picture of the green infrastructure resource of the city region.

Instead of defining a bespoke system of land divisions, types have simply been applied to all of the non-overlapping polygons from Ordnance Survey's MasterMap Topography Layer. The main advantages of this approach are enumerated in a document written by The Mersey Forest and Ordnance Survey and published by RICS called The Value of Mapping Green Infrastructure[285].

In order to classify the MasterMap polygons, the following process was employed. Each step only classifies polygons that haven't already been classified, except where otherwise specified.

- Firstly, a figure, called E, was calculated for each shape which is a measure of how intricate it is, or conversely how similar to a circle of the same area. For example, a long thin shape such as a river will have a higher E than a round or square shape such as a pond.
- Areas where land is identified in MasterMap as pylon, rail, road or track, path, steps, building, glasshouse or slope and where the area is identified as man-made – defined as 'features that have been constructed, for example, areas of tarmac or concrete' – were classed as not green infrastructure.
- Shapes identified in MasterMap as tidal water were classed as water course.
- Shapes identified in MasterMap as inland water were classified as follows.
- E < 3.5: water body
- E between 3.5 & 5 and area < 1ha: water course
- E between 3.5 & 5 and area > 1ha: water body
- E > 5: water course
- Areas where land is identified in MasterMap as natural environment and is described as trees, but not scattered trees, were classed as woodland.
- Areas where land is identified in MasterMap as natural environment and is described as marsh land were classed as wetland.
- Areas where land is identified in MasterMap as orchard were classed as orchard.
- Areas where land is identified in MasterMap as natural environment were classed as grassland, heathland, moorland or scrubland.
- Polygons with their centroids within areas classed in the local authority Open Space Surveys as natural/semi-natural were classed as grassland, heathland, moorland or scrubland.
- Areas where land is identified in MasterMap as rail were classed as grassland, heathland, moorland or scrubland.

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[284] http://www.communities.gov.uk/publications/planningandbuilding/planningpolicyguidance17 For more information about how this typology differs from the PPG17 typology please refer to http://www.greeninfrastructurenw.co.uk/resources/A_Green_Infrastructure_Mapping_Method.pdf
[285] http://www.merseyforest.org.uk/files/The_Value_of_Mapping_Green_Infrastructure_pdf.pdf

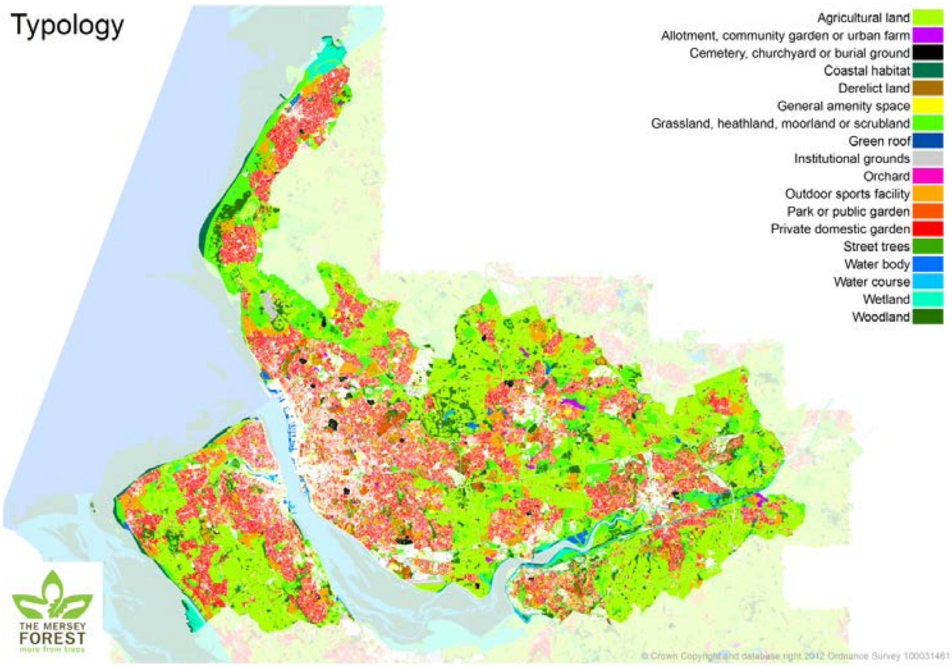
- Areas where land is identified in MasterMap as general surface or multi surface, the shape area is less than or equal to 800m^2 and E is less than or equal to 10 were classed as private domestic garden.
- Areas where land is identified in MasterMap as unclassified were classed as derelict land.
- Areas where land is identified in MasterMap as foreshore were classed as coastal habitat.
- Other areas where land is identified in MasterMap as general surface or multi surface were classed as general amenity space.
- Areas where land is identified in MasterMap as roadside were classed as general amenity space.
- Areas where MasterMap annotation indicates that the land is allotments were classed as allotment, community garden or urban farm.
- Areas where MasterMap annotation indicates that the land is used for football, rugby, cricket, bowling, golf, tennis, recreation ground, sports ground or playing field was classed as outdoor sports facility.
- Areas where MasterMap annotation indicates that the land is a cemetery or graveyard were classed as cemetery, churchyard or burial ground.
- Polygons with their centroids within areas classed in the local authority Open Space Surveys as parks were classed as public park or garden.
- Areas where land is identified in MasterMap as general surface, shape area is greater than or equal to 0.6ha and E is less than or equal to 4 were classed as agricultural land.
- Polygons of area greater than or equal to 0.3ha and E less than or equal to 5, and polygons intersecting a 2m buffer of these were classed as agricultural land.
- Polygons of area greater than or equal to 0.6ha were classed as grassland, heathland, moorland or scrubland.
- Areas where MasterMap annotation indicates that the land is part of the grounds of a school, university, college, museum, library or other educational establishment were classed as institutional grounds.
- Polygons intersecting a 10m buffer of those already classed as agricultural land were also classed as agricultural land.
- Polygons adjoining buildings of area greater than 150m^2 were classed as institutional grounds.
- Remaining polygons were classed as general amenity space.
- The included part of the Irish Sea was reclassified as water body.
- Polygons classified as part of the Liverpool Green Infrastructure Strategy[286] were reclassified to match that more accurate classification.
- Polygons classified as part of the GreenPrint for Growth study (an ongoing green infrastructure study focussing on the North Liverpool South Sefton Strategic Regeneration Framework area) were reclassified to match that more accurate classification.
- Polygons classified as park or public garden within Knowsley Park were reclassified as agricultural land (to correct a particularly prominent inaccuracy caused by the above steps).
- Polygons identified in MasterMap as roadside and where there is significant tree cover according to local authority tree data were reclassified as street trees.
- Polygons identified in MasterMap as roadside and where there is significant tree cover according to LiDAR height data combined with colour infrared imagery were reclassified as street trees. These dataset were only available for Warrington.

It was possible to measure the classification accuracy resulting from this process by comparison with typology mapping carried out by Cheshire West and Chester Council and The Mersey Forest using less automated methods. The results are shown below.

[286] http://www.ginw.co.uk/liverpool

	Compared with Cheshire mapping	Compared with Liverpool Knowledge Quarter mapping
Polygons correctly classified	91%	89%
Area correctly classified	60%	91%
Area correctly classified excluding coastal habitat[287]	71%	91%

Map 45 Typology of green infrastructure in Liverpool City Region



[287] The coastal habitat type, which covers large expanses of Liverpool City Region, wasn't used in the Cheshire mapping

Functionality

The next step was to determine which polygons currently perform which of a list of 28 functions, which again comes from the general methodology. The functions are defined below, which references confirming that green infrastructure can perform them where necessary and available.

Recreation – public

Anyone can use for recreational purposes (formal/informal and active/passive), without having to pay or have access to keys. Can include areas which are closed at night, on specific days, or seasonally but a judgement call will be required as to whether this restricts public use. Can include sports fields, fishing lakes, playgrounds, etc, and open access land.

Recreation – private

Land which is used for recreation but only by owners of the land or those invited by the owners to use. This includes private gardens and other privately owned green spaces to which access for the public is prohibited.

Recreation public – with restrictions

Public use for recreational purposes (formal/informal and active/passive) is allowed but is restricted to those who pay or have keys. Can include sports fields, golf courses, fishing lakes, allotments, etc, but not public rights of way.

Green travel route

Off road routes through greenery for pedestrians and cyclists (for recreational purposes as well as for getting between places), can include public rights of way, Sustrans, and private routes which are not on roads. Useful in urban areas and often located close to large centres of population. Also includes the green infrastructure which surrounds green travel routes, making them an attractive alternative route.

Aesthetic (CABE, 2005)

Improves the image of an area for people as they arrive, and for those who reside there. Examples may include street trees, trees along major roads, etc. Applies equally to towns, cities and the rural landscape. Green infrastructure can make the town/village etc. a more attractive place to live and visit. The improved aesthetic which green infrastructure can provide will be reflected in surrounding property prices.

Shading from sun (Huang et al. 2006, Parker, 1981)

Shading of people, buildings, and surfaces from solar radiation to reduce temperatures and increase comfort levels. Usually provided by trees and taller plants and vegetation. Particularly found in urban areas to reduce the urban heat island, this function will become more critical as we have to adapt to a changing climate. Green infrastructure which provides shade will also be important for protecting agricultural land and other species from solar damage.

Evaporative cooling (Kramer & Kozlowaki, 1960)

As plants transpire water is evaporated from their surfaces cooling their immediate locality. All types of green infrastructure can provide this function, including open water. Plants with a larger leaf area are likely to be better than those with a smaller leaf area. During a drought, irrigation is likely to be necessary to maximise this function in plants, whilst open water will continue to be valuable in its own right.

Trapping air pollutants (Hill, 1971, Beckett et al., 1998, Smith, 1990, Hewitt et al., 2005)

Removal of pollutants, especially ozone, nitrogen dioxide and particles from the air, through uptake via leaf stomata and deposition on leaf surfaces. Once inside the leaf, gases diffuse into intercellular spaces and may be absorbed by water films to form acids or react with inner leaf surfaces. This function is usually associated with more urban areas, especially close to travel routes.

Noise absorption (Fang & Ling, 2002)
Screening of noise, especially from major transport routes. Requires certain types of green infrastructure which are tall enough to incept and absorb sound waves. This function is usually associated with more urban areas, especially close to travel routes.

Habitat for wildlife (Tree People, 2009)
Providing a habitat for wildlife – a place to live with a source of food. Different types of green infrastructure will provide habitats for a widely different range of species. The range of species will also be dependent on other factors such as climate and disturbance.

Corridor for wildlife (Benedict & McMahon, 2006)
Conduit of green and blue spaces through which wildlife can disperse to and from habitat spaces. This function will increase in importance in the future; species will need the capacity to move upwards and northwards as the climate changes. Connectivity is vital for this function. Different types of green infrastructure will provide a corridor for a widely different range of species. Range of species will also be dependent on other factors such as climate and disturbance.

Soil stabilisation (Barker, 1995)
Root structures of all vegetation can help improve the strength and stability of soil, holding together the top soil and preventing it from eroding.

Heritage
Historic links in the landscape (including ancient woodlands, canals, designated sites and monuments). Heritage is "that which is inherited".

Cultural asset
Green space used for cultural purposes, the hosting of public art, events and festivals. Examples include international garden festivals and sculpture parks.

Carbon storage (Milne & Brown, 1995)
Removing carbon from the atmosphere and storing it in plants, trees and soils. Trees and peat soils are particularly important types of green infrastructure for storing carbon. Varying types of green infrastructure will take different amounts of time to sequester carbon; some types of green infrastructure are slow growing in nature and therefore will take longer to sequester carbon. Stored carbon in trees will stay locked away inside the wood if felled for material substitution.

Food production (TCPA, 2008)
Land used for growing crops or the grazing of animals.

Timber production
Growing trees and woodlands for timber. Includes for use as a substitute for other materials. Can be on a large scale for construction materials or a smaller scale for smaller wood products. Stored carbon in trees will stay locked away inside the wood if felled for material substitution.

Biofuels production
Using vegetation as biofuels – a form of energy production. Biofuel crops include wood from trees which may or may not be coppiced, miscanthus, rapeseed and waste from other crops.

Wind shelter
Green infrastructure can provide shelter from winds at a local level by slowing or diverting currents.

Learning
Opportunities for lifelong learning. Green infrastructure can provide a backdrop for outdoor classrooms and learning outside of the indoor school environment, and also a setting for learning new skills that may help adults back to work.

Inaccessible water storage
Water stored in soils and vegetation. Certain types of sustainable urban drainage systems and soils will store large amounts of water. Certain soils such as clay and peat will store more water than others. This water is inaccessible for human use or for irrigation.

Accessible water storage
Water stored in ponds, lakes, reservoirs and certain wetlands. This water is accessible for human use and for irrigation should it be required.

Water interception (Centre for Urban Forest Research, 2002)
Interception of rainwater before it reaches the ground, e.g. by the leaves of trees and plants. This will slow the flow of water to the ground. All types of green infrastructure will intercept water in some way, though certain types with a greater leaf area will intercept a greater amount and slow its flow to greater extent. This can help to reduce the risk of flooding.

Water infiltration
Vegetation and roots aid in the movement of rainwater and floodwater into the ground. Green infrastructure will help water to drain naturally into the soil. Includes both surface infiltration and deep infiltration. Green infrastructure is a permeable surface as opposed to hard surfacing such as concrete. It aids in the natural passage of water to the ground – helping reduce the risk of flooding.

Coastal storm protection
Green infrastructure can be used to protect infrastructure and agriculture close to the shore. It can protect against winds, sea spray and slow the speed and impact of waves and large tidal surges. Could include areas of woodland and marsh.

Water conveyance
Green infrastructure can transport water to areas which are in need of water and also away from areas at risk of saturation or flooding. Examples include rivers and canals. Irrigation ditches in agricultural land are another example of water conveyance.

Pollutant removal from soil/water (Barret et al. 2005)
Vegetation can remove pollutants from soil and water. For example green infrastructure at the side of the road can clean contaminated road runoff (reducing concentrations of pollutants such as heavy metals), and certain plants can remove pollutants from contaminated soil.

Flow reduction through surface roughness
The speed and amount of water passing through a site can be reduced by vegetation. If the site has a varied green topography as opposed to hard standing, water will be retained onsite for longer, potentially helping to reduce flooding. Some types of green infrastructure perform this function more than others – for example, a woodland floor tends to be rougher than grass.

The following table shows which types of green infrastructure perform which functions.

- Where a cell contains a value of 1.00, land of the type in question almost always performs the function in question to a level above a notional threshold (where it becomes 'significant'), so all polygons of that type can simply be said to perform that function.
- Where a cell contains a value of 0.00, land of the type in question almost never performs the function in question to a level above the threshold, so all polygons of that type can simply be said not to perform that function.
- Where there is a letter in a cell, land of the type in question sometimes performs the function in question to a level above the threshold and sometimes doesn't, depending on

other factors. The conditions in the second part of the table were used to determine whether each polygon of that type would be said to perform that function. Most of the conditions involve comparison with other datasets.

- Where a cell contains a value greater than zero and less than one, land of the type in question sometimes performs the function in question to a level above the threshold and sometimes doesn't, depending on other factors. Data locating these factors was not available, however, so instead the estimated likelihood of performing the function (the value in the cell) was applied to all polygons of the type. These likelihoods were estimated using true frequencies taken from the Liverpool Green Infrastructure Strategy mapping together with expert judgement, taking into account the less urban nature of the city region as a whole.

Table 11 Linking typology and function

	recreation - public	recreation - private	recreation - public with restrictions	green travel route	aesthetic	shading from the sun	evaporative cooling	trapping air pollutants	noise absorption	habitat for wildlife	corridor for wildlife	soil stabilisation	heritage	cultural asset	carbon storage	food production	timber production	biofuels production	wind shelter	learning	inaccessible water storage	accessible water storage	water interception	water infiltration	coastal storm protection	water conveyance	pollutant removal from soil/water	flow reduction through surface roughness
Agricultural land	0.00	0.00	0.00	a	1.00	0.00	1.00	0.00	0.00	c	d	0.00	f	0.00	r	1.00	0.00	0.01	0.00	0.00	k	0.00	0.00	l	0.00	n	0.10	0.00
Allotment, community garden or urban farm	0.10	0.00	0.90	a	1.00	0.00	1.00	0.00	0.00	c	d	0.00	f	0.00	r	1.00	0.00	0.00	0.00	j	k	0.00	0.00	l	0.00	n	0.10	0.00
Cemetery, churchyard or burial ground	0.95	0.00	0.05	a	1.00	0.10	1.00	0.10	b	c	d	e	f	1.00	s	0.00	0.00	0.00	0.10	0.00	k	0.00	0.06	l	0.00	n	0.35	0.00
Coastal habitat	1.00	0.00	0.00	a	1.00	0.00	1.00	0.00	0.00	c	d	e	f	0.00	r	0.00	0.00	0.00	0.00	j	k	0.00	0.00	l	m	n	0.10	0.00
Derelict land	0.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	c	d	e	f	0.00	r	0.00	0.00	0.00	0.00	0.00	k	0.00	0.00	l	0.00	n	0.10	0.00
General amenity space	1.00	0.00	0.00	0.00	1.00	0.05	1.00	0.05	b	c	d	e	f	0.00	s	0.00	0.00	0.00	0.05	0.00	k	0.00	0.03	l	0.00	n	0.20	0.00
Grassland, heathland, moorland or scrubland	0.30	0.00	0.00	a	1.00	0.30	1.00	0.30	b	c	d	e	f	0.00	s	0.00	0.00	0.00	0.30	0.00	k	0.00	0.20	l	m	n	0.50	1.00
Green roof	0.05	0.20	0.00	0.00	1.00	0.05	1.00	0.05	b	1.00	0.00	0.00	0.00	0.05	s	0.05	0.00	0.00	0.05	j	k	0.00	0.03	0.00	0.00	0.00	1.00	0.00
Institutional grounds	0.00	0.00	0.00	0.00	1.00	0.10	1.00	0.10	b	c	d	e	f	0.00	s	0.00	0.00	0.00	0.10	j	k	0.00	0.06	l	0.00	n	0.20	0.00
Not green infrastructure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orchard	0.20	0.60	0.20	a	1.00	0.60	1.00	0.60	b	1.00	d	e	f	1.00	s	1.00	0.00	0.00	0.60	0.00	1.00	0.00	0.40	l	0.00	n	1.00	0.20
Outdoor sports facility	0.30	0.00	0.70	0.00	1.00	0.00	1.00	0.00	0.00	c	d	e	f	0.00	r	0.00	0.00	0.00	0.00	j	k	0.00	0.00	l	0.00	n	0.15	0.00
Park or public garden	0.90	0.00	0.10	a	1.00	0.20	1.00	0.20	b	c	d	e	f	1.00	s	0.00	0.00	0.00	0.20	j	k	0.00	0.20	l	0.00	n	0.35	0.00
Private domestic garden	0.00	1.00	0.00	0.00	1.00	0.10	1.00	0.10	b	c	d	e	f	0.00	s	0.00	0.00	0.00	0.10	0.00	k	0.00	0.06	l	0.00	n	0.20	0.00
Street trees	0.00	0.00	0.00	a	1.00	0.30	1.00	0.30	b	1.00	d	e	f	0.00	s	0.00	0.00	0.00	0.30	0.00	k	0.00	0.20	l	0.00	0.00	0.45	0.00
Water body	0.60	0.10	0.05	a	1.00	0.00	1.00	0.00	0.00	c	d	0.00	f	0.00	0.00	0.00	0.00	0.00	0.00	j	0.00	q	0.00	0.00	0.00	p	0.20	0.00
Water course	0.80	0.00	0.05	a	1.00	0.00	1.00	0.00	0.00	c	d	0.00	f	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	q	0.00	0.00	0.00	1.00	0.20	0.00
Wetland	0.00	0.00	0.00	a	1.00	0.00	1.00	0.00	0.00	1.00	d	e	f	0.00	r	0.00	0.00	0.00	0.00	j	1.00	0.00	0.00	0.00	m	n	1.00	1.00
Woodland	0.60	0.35	0.05	a	1.00	1.00	1.00	1.00	b	1.00	d	e	f	0.01	1.00	0.00	1.00	1.00	1.00	j	1.00	0.00	0.50	l	m	n	1.00	1.00

a	if near Public Right of Way, National Cycle Network or other path
b	if near main road, railway or airport, give approximate tree cover value (cf. shading from the sun)
c	if intersects Core Biodiversity Area or habitat designation
d	if near habitat
e	if intersects at risk soil
f	if intersects heritage designation
g	if designated village green
j	if near educational institution, visitor centre or urban farm
k	if intersects high porosity soil
l	if intersects freely draining soil
m	if sufficient total width of semi-natural types perpendicular to the coast and intersecting a buffer of it
n	if has a watercourse running through it
p	if connects to a watercourse
q	if freshwater
r	if high soil carbon density
s	if high soil carbon density; if not give approximate tree cover value
t	if big enough to be a sustainable habitat for fish

The sum of the likelihoods of performing the functions was also then calculated for each polygon to give multifunctionality.

The functions that green infrastructure performs lead to benefits for humans and other species. A list of these that is widely accepted has been developed by the Natural Economy Northwest programme[288].

- Climate change adaptation and mitigation
- Flood alleviation and water management
- Quality of place
- Health and well-being
- Land and property values
- Economic growth and investment
- Labour productivity
- Tourism
- Recreation and leisure

[288] http://www.naturaleconomynorthwest.co.uk/download.php?The Economic Value of Green Infrastructure.pdf

- Land and biodiversity
- Products from the land

For mapping purposes, climate change adaptation and mitigation are separated because the functions that lead to them are different. Where the benefits are currently provided they can be mapped by creating multifunctionality maps based on subsets of the complete function list. The network of causality between functions and benefits is very complicated, but it is possible to identify those functions that most directly and undeniably lead to each benefit. The following table illustrates this relationship.

Table 12 Function and benefit matrix

	FUNCTION																											
BENEFIT	Recreation - public	Recreation - private	Recreation - public with restrictions	Green travel route	Aesthetic	Shading from sun	Evaporative cooling	Trapping air pollutants	Noise absorption	Habitat for wildlife	Corridor for wildlife	Soil stabilisation	Heritage	Cultural asset	Carbon storage	Food production	Timber production	Biofuels production	Wind shelter	Learning	Inaccessible water storage	Accessible water storage	Water interception	Water infiltration	Coastal storm protection	Water conveyance	Pollutant removal from soil/water	Flow reduction through surface roughness
Climate change adaptation	■	■	■			■	■			■	■	■									■	■	■	■	■	■	■	■
Climate change mitigation	■	■	■	■											■	■	■	■										
Flood alleviation and water management												■									■	■	■	■	■	■	■	■
Quality of place					■	■	■	■	■				■	■					■									
Health and well-being	■	■	■	■	■	■	■	■	■											■								
Land and property values																												
Economic growth and investment					■																							
Labour productivity																				■								
Tourism	■		■										■	■														
Recreation and leisure	■	■	■	■										■														
Land and biodiversity										■	■	■															■	
Products from the land												■				■	■	■			■			■				

In addition, this study has identified six priorities for the city region inspired by the benefits that green infrastructure can provide. These can be mapped in a similar way to the benefits. The following table indicates which functions correspond to which priorities.

Table 13 Function and priority matrix

		FUNCTION																											
		Recreation - public	Recreation - private	Recreation - public with restrictions	Green travel route	Aesthetic	Shading from sun	Evaporative cooling	Trapping air pollutants	Noise absorption	Habitat for wildlife	Corridor for wildlife	Soil stabilisation	Heritage	Cultural asset	Carbon storage	Food production	Timber production	Biofuels production	Wind shelter	Learning	Inaccessible water storage	Accessible water storage	Water interception	Water infiltration	Coastal storm protection	Water conveyance	Pollutant removal from soil/water	Flow reduction through surface roughness
PRIORITY	Setting the Scene for Growth	■			■	■															■								
	Supporting Adaptation to Climate Change	■	■	■			■	■			■	■	■									■	■	■	■	■	■	■	■
	Providing Recreation, Leisure and Tourism	■	■	■	■									■	■														
	Enhancing the Ecological Framework										■	■																■	
	Developing the Rural Economy	■		■									■	■	■		■	■	■			■			■				
	Supporting Health and Well-being	■	■	■	■	■	■	■	■	■							■				■								

Needs

In order to plan interventions, it is necessary to know where there is particular need for each function, as well as where they are currently performed. Therefore the areas where there is the greatest need for each function were identified. Because need is not necessarily linked to provision, this mapping was carried out independently from the previous stages and the MasterMap Topography Layer. The following table explains how greatest need was mapped for each function.

Table 14 Thresholds for identification of need

FUNCTION	THRESHOLDS
Recreation - public	Reverse Access to Natural Green Space Standard score (see section 0) > 8 or percentage households without a car >70% or Index of Multiple Deprivation health score >2.5 or percentage population aged 0 - 15 >25% or main town centre
Recreation - private	Reverse Access to Natural Green Space Standard score > 8 or percentage households without a car >70% or Index of Multiple Deprivation health score >2.5 or percentage population aged 0 - 15 >25% or main town centre
Recreation - public with restrictions	Reverse Access to Natural Green Space Standard score > 8 or percentage households without a car >70% or Index of Multiple Deprivation health score >2.5 or percentage population aged 0 - 15 >25% or main town centre
Green travel route	Population movement gradient >70°
Aesthetic	100m buffer of key gateways, 25m buffer of main roads, railways and canals
Shading from sun	Lower Layer Super Output Areas with population density >10,000km^{-2} in 2008, 2014 or 2024, >500 population with limiting long-term illness, >30% population aged 65+ (male) or 60+ (female), or >25% population aged 0 - 15, 100m buffer of schools, main town centres
Evaporative cooling	Urban Lower Layer Super Output Areas with >500 population with limiting long-term illness, >30% population aged 65+ (male) or 60+ (female), or >25% population aged 0 - 15
Trapping air pollutants	Population density >5,000km^{-2} in 2008, 2014 or 2024 and Core Biodiversity Areas, both within 100m of motorways or A roads

Noise absorption	Population density >5,000km^{-2} in 2008, 2014 or 2024 within 30m of motorways, A roads or railways
Habitat for wildlife	Core Biodiversity Areas, Connectivity Zone
Corridor for wildlife	Connectivity Zone
Soil stabilisation	Slope >4° or Flood Zone 3 or 'sandy' soil
Heritage	50m buffer of existing heritage functionality
Cultural asset	Population density >7,000km^{-2} in 2008, 2014 or 2024
Carbon storage	Everywhere equal
Food production	Best and most versatile agricultural land
Timber production	5km buffer of potential timber station sites
Biofuels production	1km buffer of areas with energy use >50GWh/km^2
Wind shelter	Average wind speed >5.5m/s at 10m above ground level
Learning	Population density >7,000km^{-2} in 2008, 2014 or 2024, 100m buffer of educational establishments
Inaccessible water storage	Upstream of urban historic flooding
Accessible water storage	Upstream of urban historic flooding, 100m buffer of most multifunctional green infrastructure, 100m buffer of best and most versatile agricultural land
Water interception	Upstream of urban historic flooding
Water infiltration	Upstream of urban historic flooding
Coastal storm protection	Population density >1,000km^{-2} in 2008, 2014 or 2024 within 500m of the coast
Water conveyance	Downstream of urban historic flooding, best and most versatile agricultural land
Pollutant removal from soil/water	Best and most versatile agricultural land
Flow reduction through surface roughness	Upstream of urban historic flooding

The reverse Access to Natural Green Space Standard (ANGSt) score was calculated as follows.

- Estimated population figures for 2008 were obtained from the Office for National Statistics.
- Housing projection figures for 2014 and 2024 were obtained from Merseyside Information Service and used to estimate population figures for those years.
- Focal statistics calculations were run on population densities for each of the three years to each of the four distances quoted in the ANGSt documentation (300m, 2km, 5km and 10km).
- The twelve resulting datasets were added together with equal weighting.

The population movement gradient used a hydrological model as an analogy for the movement of people through the city region. Centres of population (both present and future) were made analogous to mountain peaks, and destinations (schools and centres of employment) were made analogous to low points in the terrain. A surface was interpolated and areas of greatest slope were considered to be where the greatest numbers of people would want to travel. This implies a bias towards short-range travel, which is the primary role of green travel routes.

Needs fulfilled and not fulfilled

For each function, the mapping showing provision was compared with the need mapping. This effectively splits the city into four categories of land:

- Where there is particular need and the function is currently performed, potentially fulfilling the need – these areas of land are green infrastructure assets and their functionality should be protected
- Where there is particular need but the function is not currently performed – which should be remedied, if possible, by suitable creation or enhancement of green infrastructure
- Where there is no particular need but the function is currently performed – here the green infrastructure should also be protected if possible, because there is likely to be a lower level of need, which may increase in the future, and the functionality may be mitigating a lack of provision elsewhere
- Where there is no particular need and the function is not currently performed – no action required, except to take any opportunities that present themselves, for the reasons described above

Maps were also created showing the number of needs fulfilled and not fulfilled respectively, in total and relating to each priority. Where these referred to more than one recreation function, only one need layer was used with both or all three functions, because the locations of greatest need for the three functions are the same, whilst the functions are spatially mutually exclusive in terms of provision.

Data sources

The following table shows the datasets used for the mapping.

Table 15 Data sources

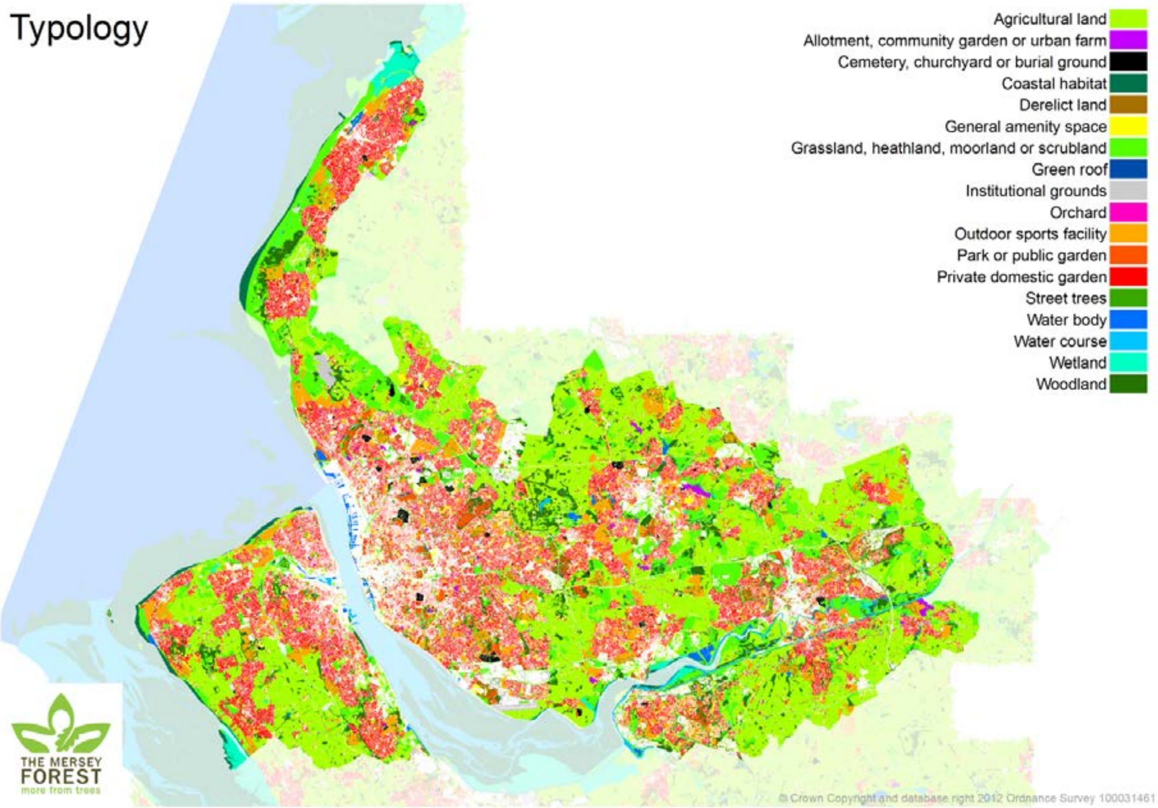
NAME	SOURCE	APPLICATION
MasterMap Topography Layer	Ordnance Survey	Primarily typology & functionality mapping
Open Space Surveys	Liverpool City Council, Sefton Council, Knowsley Council, Halton Council, Wirral Council, St Helens Council, Warrington Council, Cheshire West and Chester Council	Primarily typology & ANGSt mapping
Tree data	Liverpool City Council, Sefton	Typology mapping

	Council, Knowsley Council, Halton Council, Wirral Council, St Helens Council	
LiDAR height data	Natural England	Typology mapping
Colour infrared imagery	Natural England	Typology mapping
MasterMap Integrated Transport Layer	Ordnance Survey	Functionality & needs mapping
Railways	ESRI	Functionality & needs mapping
Special Areas of Conservation	Natural England	Functionality mapping
Special Protection Areas	Natural England	Functionality mapping
National Nature Reserves	Natural England	Functionality mapping
Sites of Special Scientific Interest	Natural England	Functionality mapping
Local Nature Reserves	Natural England	Functionality & ANGSt mapping
Local wildlife sites	Liverpool City Council, Sefton Council, Knowsley Council, Halton Council, Wirral Council, St Helens Council, Warrington Council, Cheshire West and Chester Council	Functionality mapping
Land-Form Profile	Ordnance Survey	Functionality & needs mapping
Flood Zone 3	Environment Agency	Functionality & needs mapping
World Heritage Sites	English Heritage	Functionality mapping
Scheduled Ancient Monuments	English Heritage	Functionality mapping
Heritage Parks & Gardens	English Heritage	Functionality mapping
Battlefields	English Heritage	Functionality mapping
Ancient Woodlands	Natural England	Functionality mapping
NATMAP soilscapes	Cranfield University	Functionality & needs mapping
Village Greens	Defra	Functionality & ANGSt mapping
Public Rights of Way	Liverpool City Council, Sefton Council, Knowsley Council, Halton Council, Wirral Council, St Helens Council, Warrington Council, Cheshire West and Chester Council	Functionality & ANGSt mapping
National Cycle Network	Sustrans	Functionality & ANGSt mapping
Soil carbon density	Dr Ronald Milne, Centre for	Functionality mapping

	Ecology & Hydrology	
Doorstep Greens	Natural England	ANGSt mapping
Agri-environment access routes	Natural England	ANGSt mapping
Agri-environment open access	Natural England	ANGSt mapping
Millennium Greens	Natural England	ANGSt mapping
Country Parks	Natural England	ANGSt mapping
National Nature Reserves	Natural England	ANGSt mapping
CRoW access land	Natural England	ANGSt mapping
Estimated populations 2008	Office for National Statistics	Needs mapping
Housing projections for 2014 & 2024	Merseyside Information Service	Needs mapping
Car ownership 2001	Office for National Statistics	Needs mapping
Indices of Multiple Deprivation 2007	Department for Communities & Local Government	Needs mapping
Broad age structure 2008	Office for National Statistics	Needs mapping
Educational establishments	Department for Children, Schools & Families	Needs mapping
Workplace populations 2001	Office for National Statistics	Needs mapping
Limiting long-term illness 2001	Office for National Statistics	Needs mapping
Agricultural Land Classification	Natural England	Needs mapping
Likelihood of Best & Most Versatile Agricultural Land	Natural England	Needs mapping
Core Biodiversity Areas	Merseyside Environmental Advisory Service	Functionality & needs mapping
Connectivity Zone	Merseyside Environmental Advisory Service	Needs mapping
Summary Valuations 2005	Valuation Office Agency	Needs mapping
Wind Speed Database	Department for Business, Enterprise & Regulatory Reform	Needs mapping
Historic flooding	Liverpool City Council, Sefton Council, Knowsley Council, Halton Council, Wirral Council, St Helens Council, Warrington Council	Needs mapping

13. Typology map

Figure 43 Typology map



14. Functionality maps

Figure 44 Accessible water storage

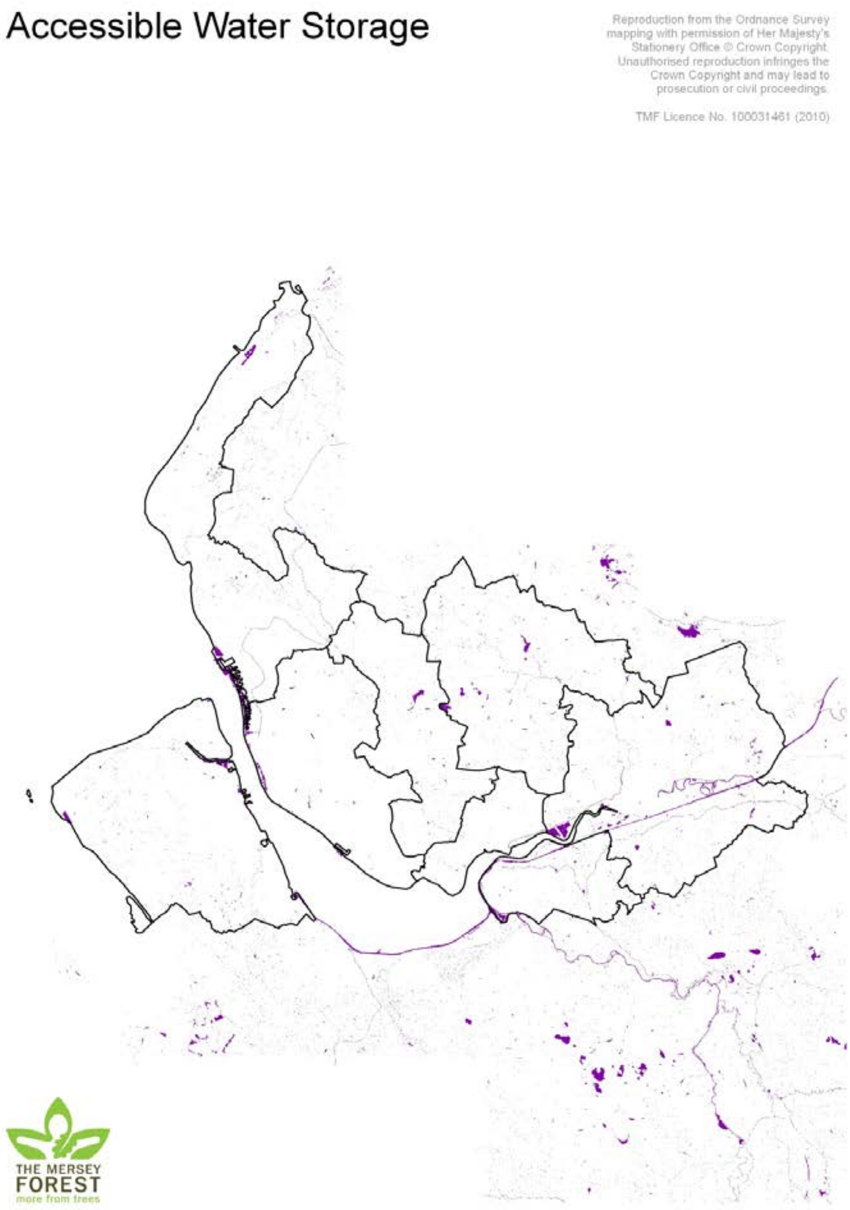


Figure 45 Aesthetic

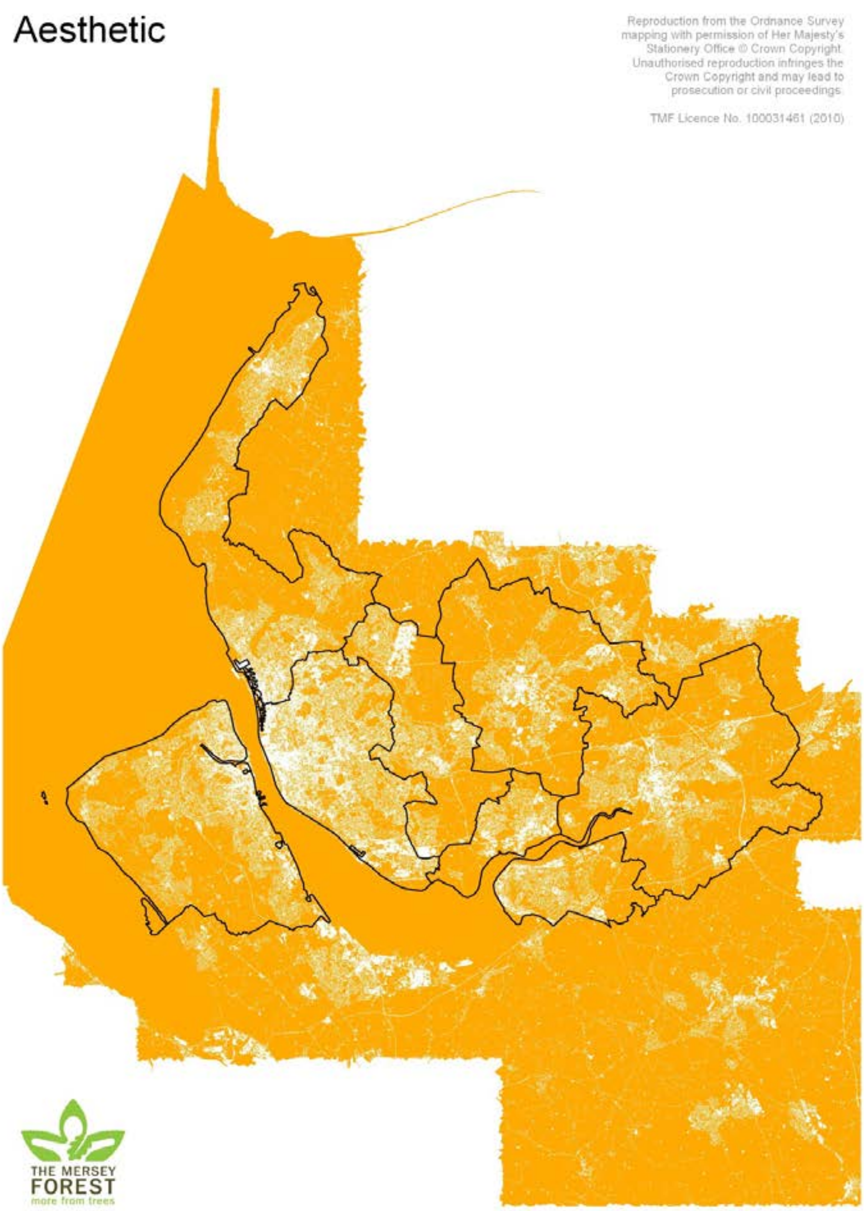


Figure 46 Biofuels production

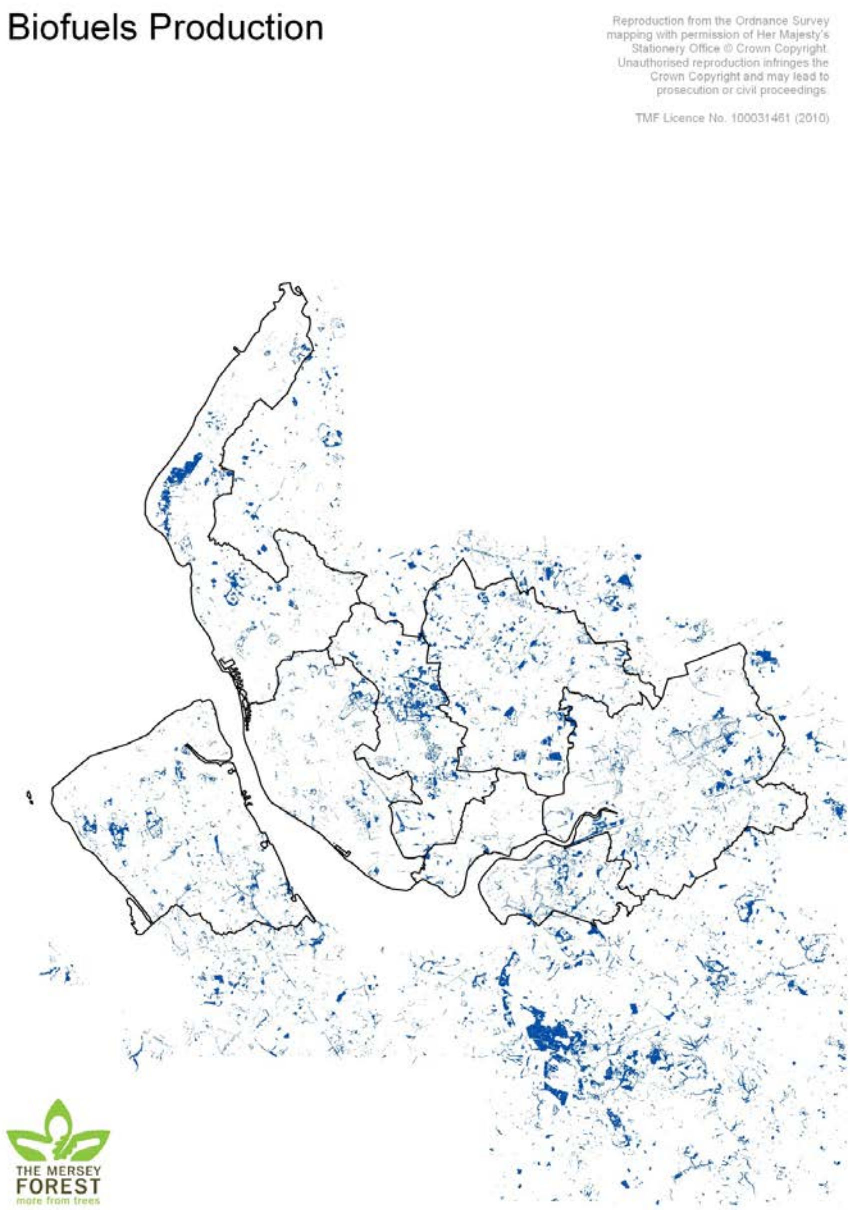


Figure 47 Carbon storage

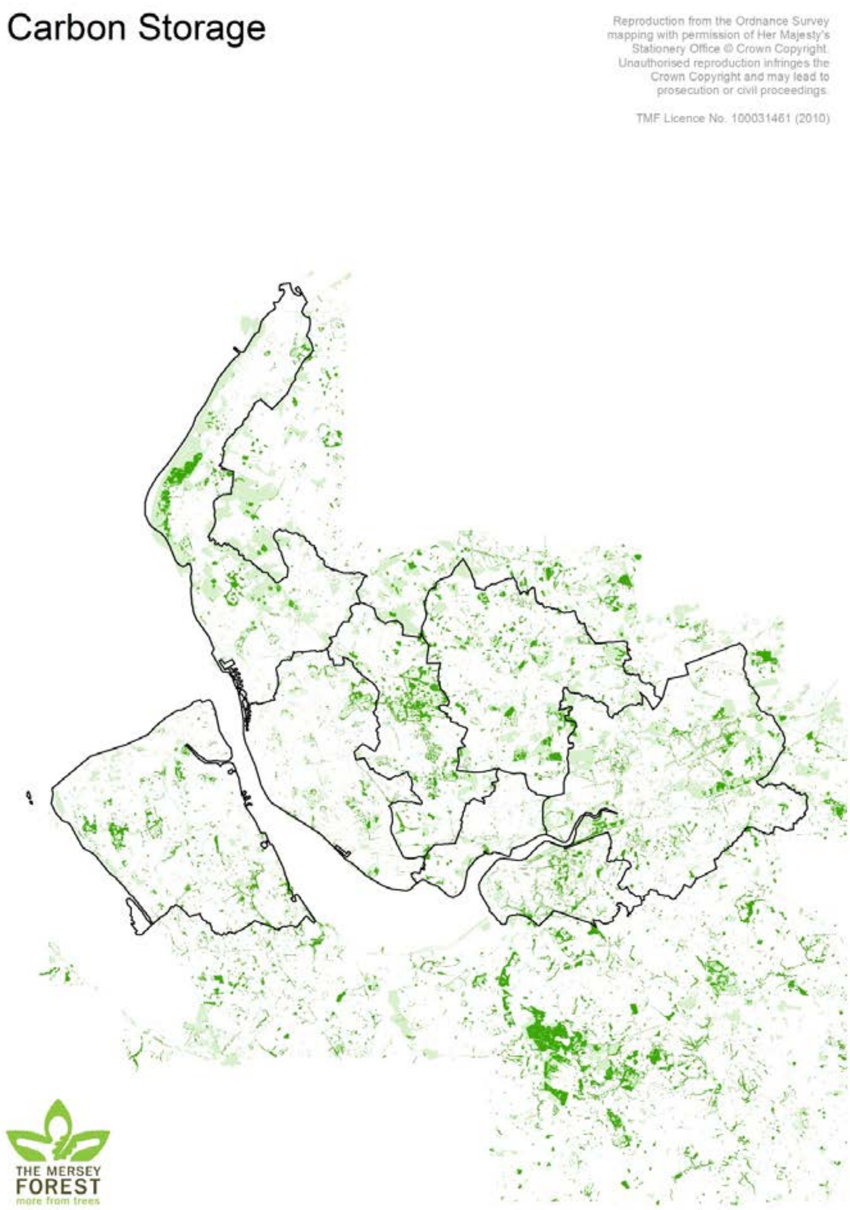


Figure 48 Coastal storm protection

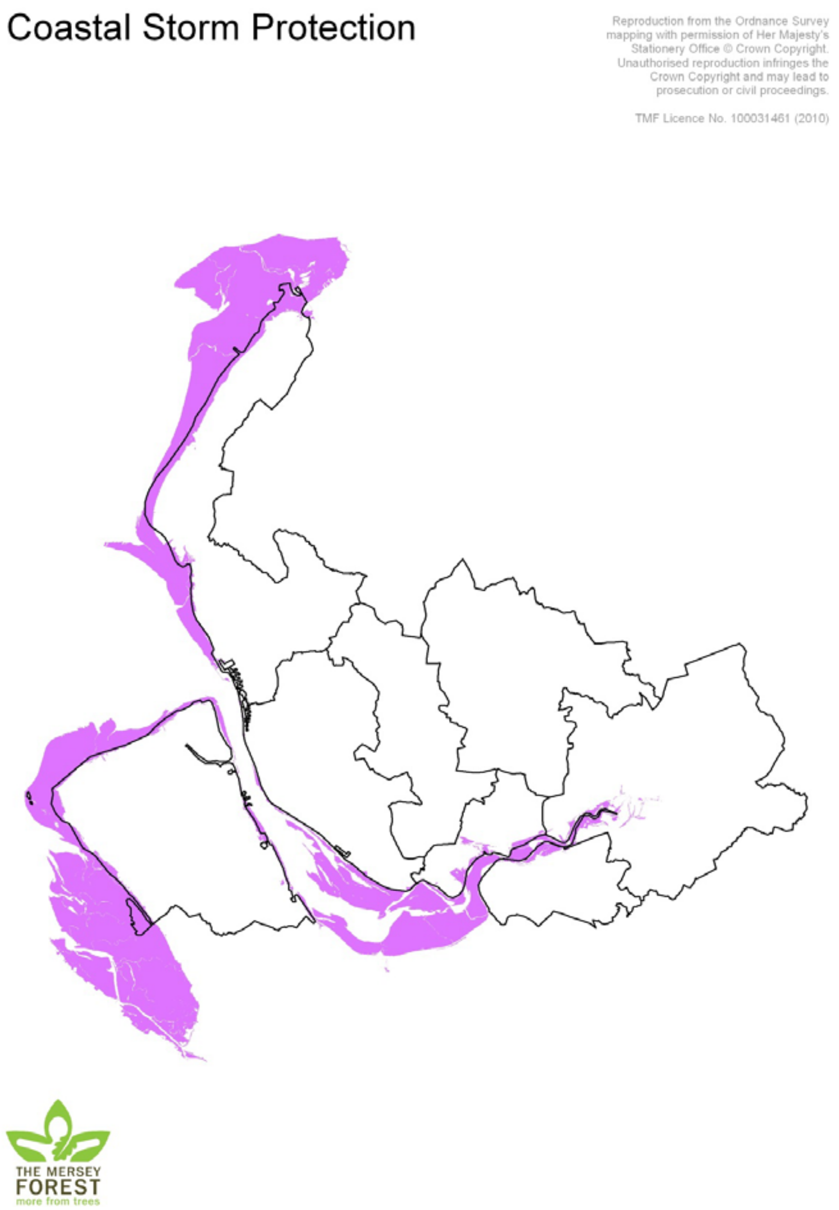


Figure 49 Corridor for wildlife

Figure 50 Cultural asset

Figure 51 Evaporative cooling

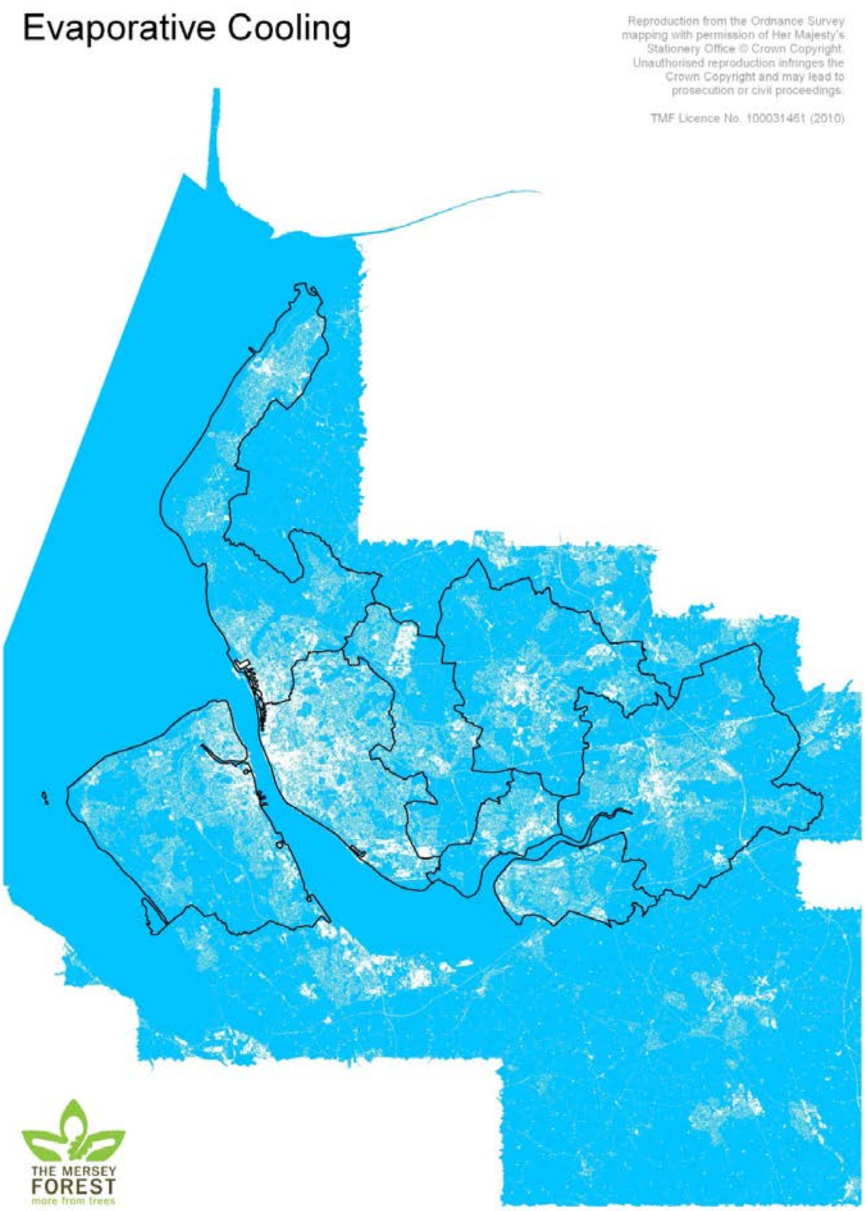


Figure 52 Flow reduction through surface roughness

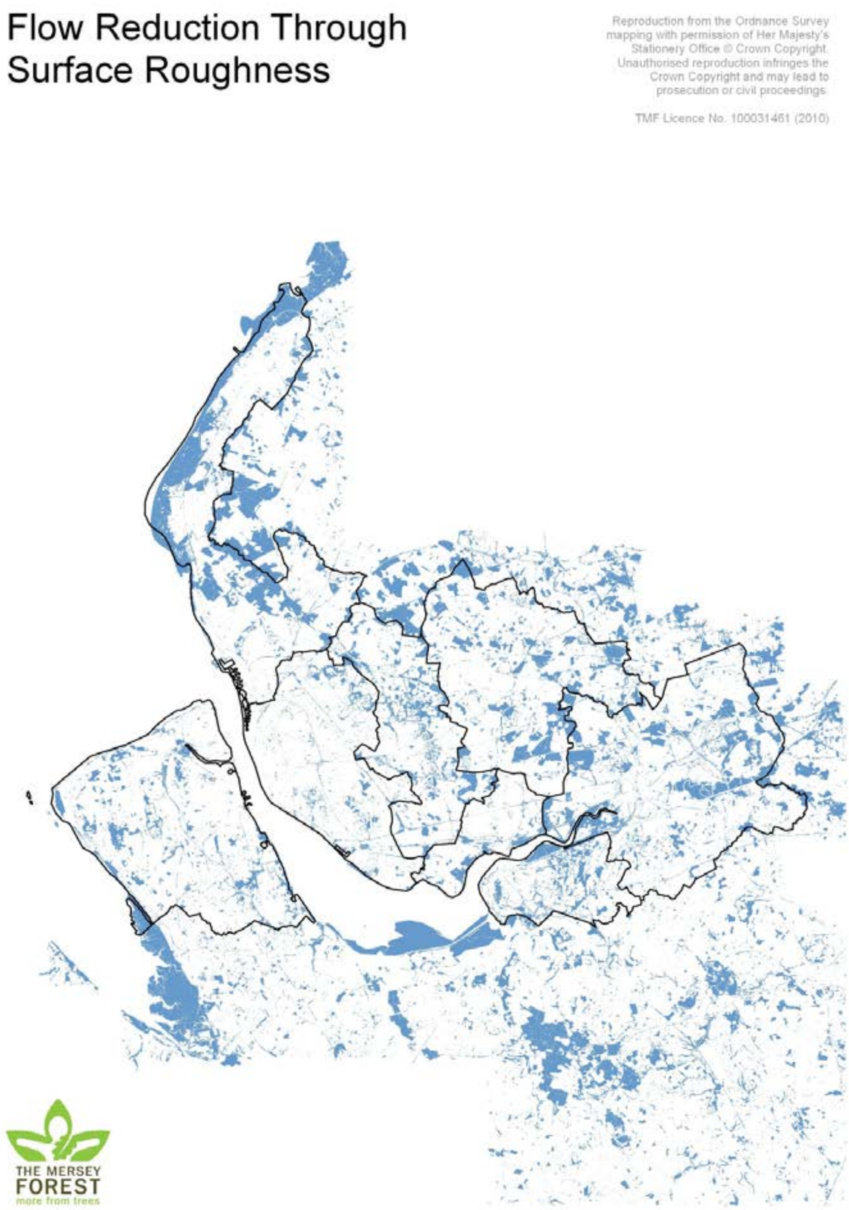


Figure 53 Food production

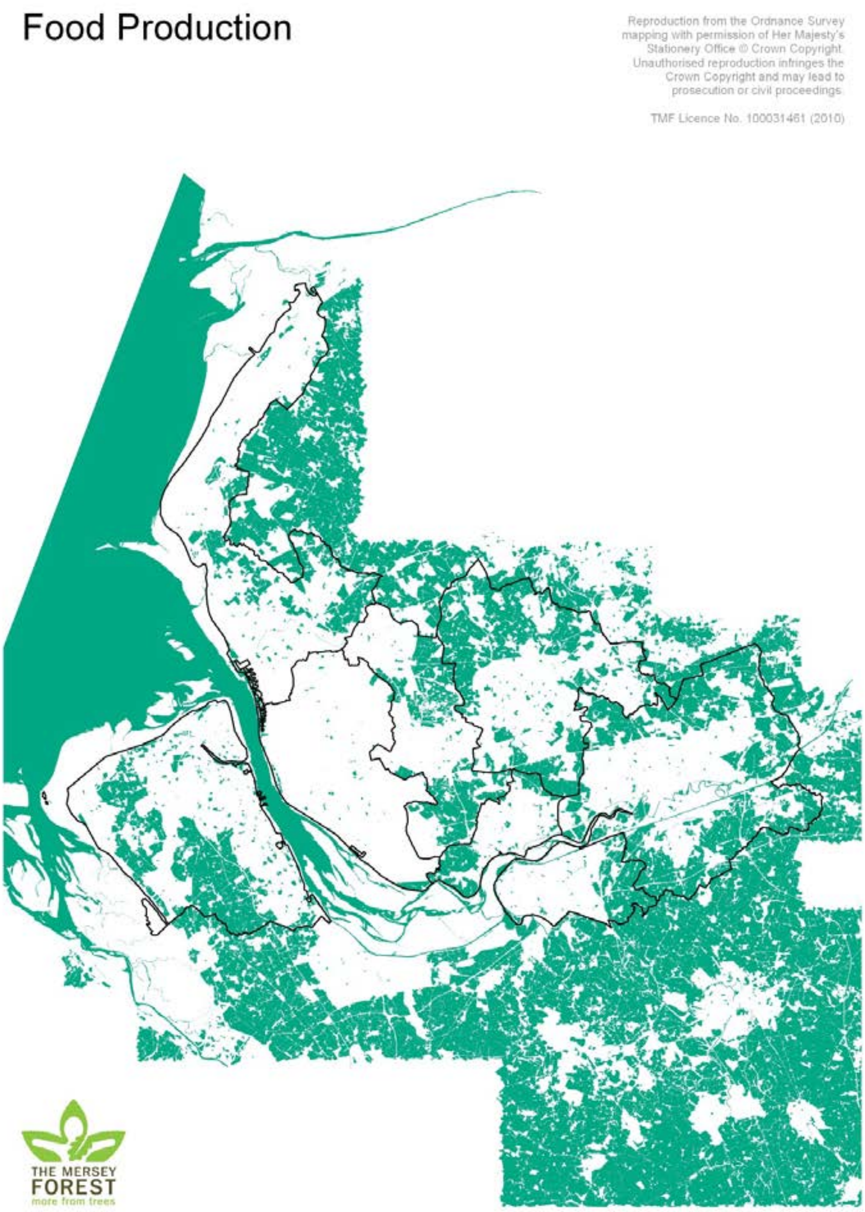


Figure 54 Green travel route

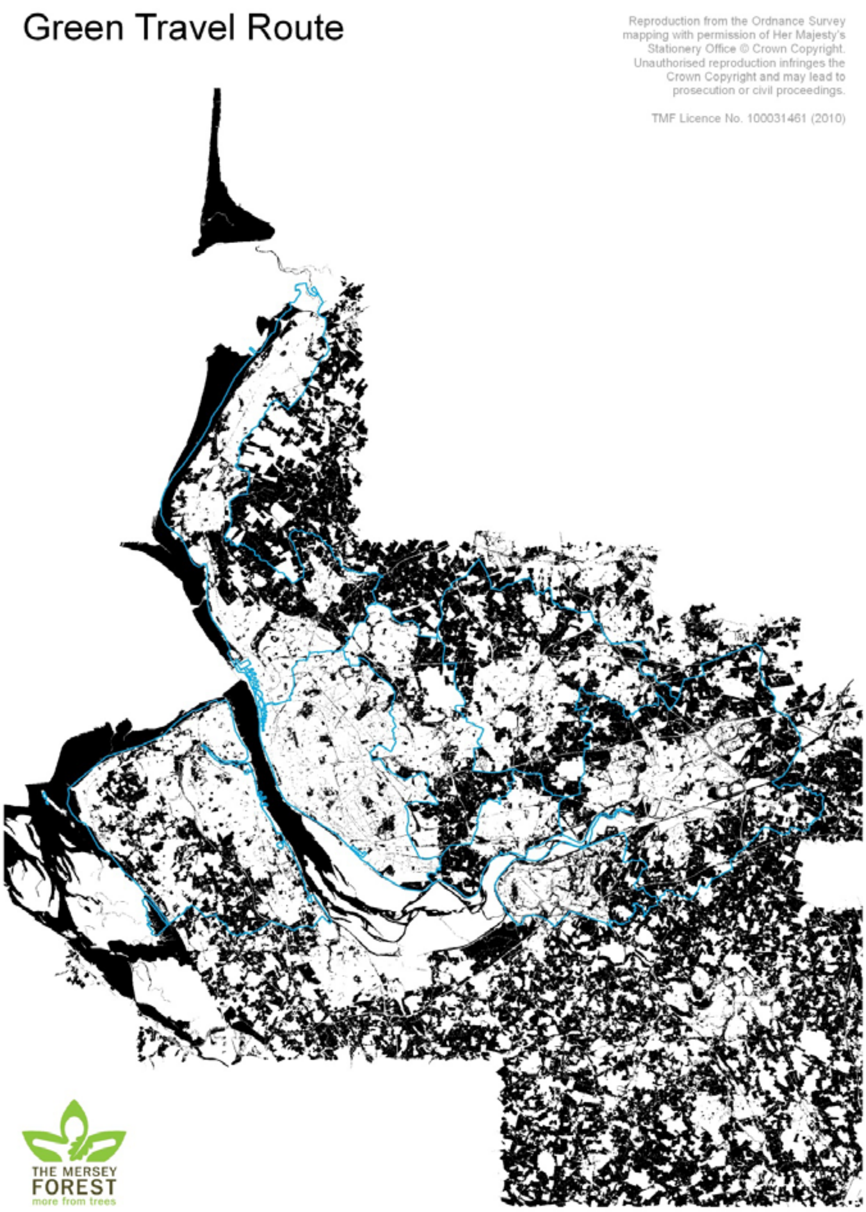


Figure 55 Habitat for wildlife

Figure 56 Heritage

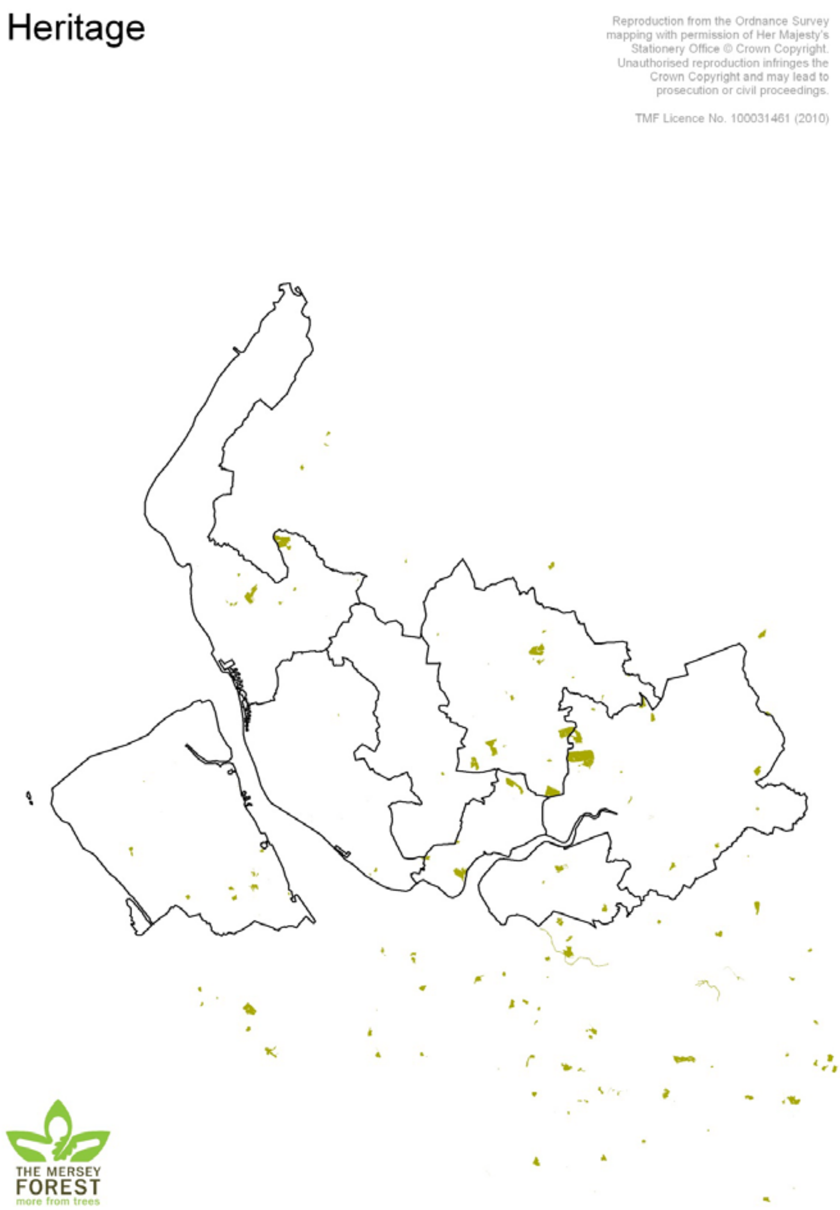


Figure 57 Inaccessible water storage

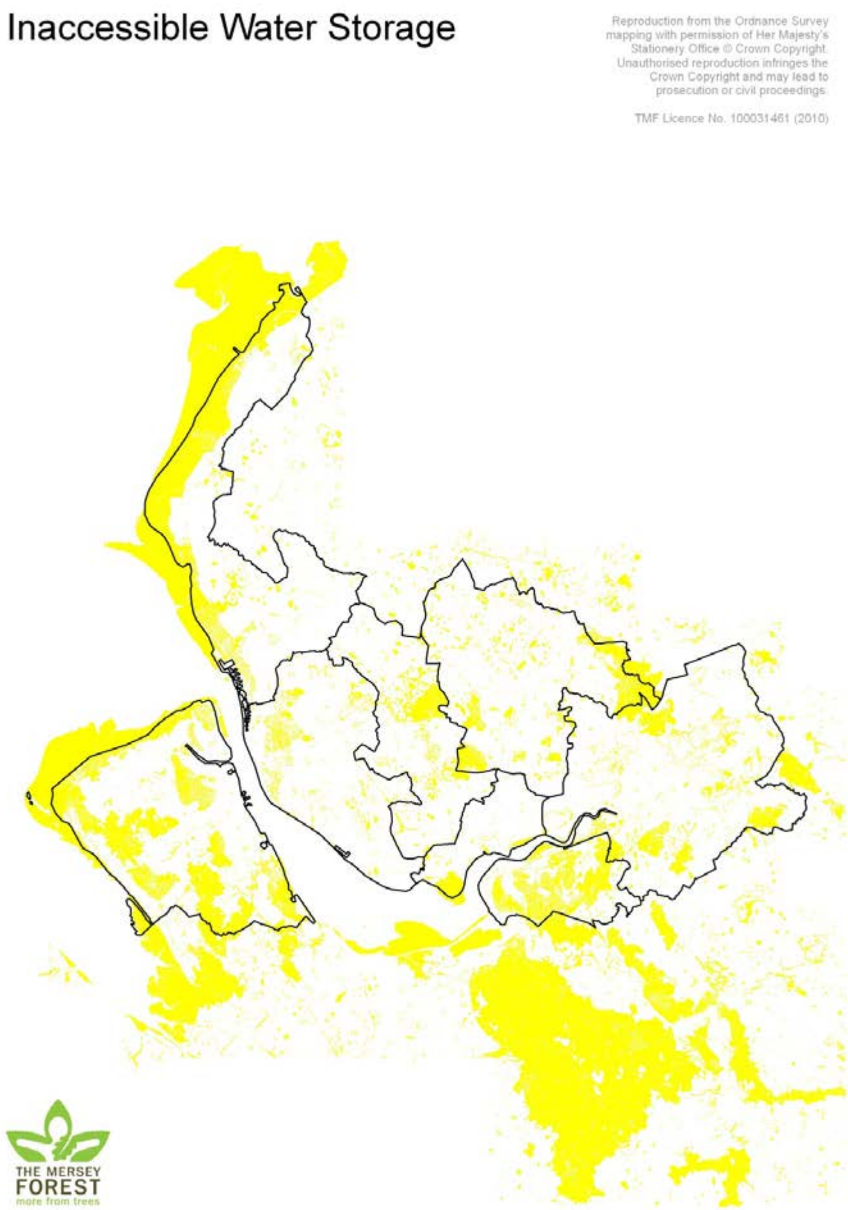


Figure 58 Learning

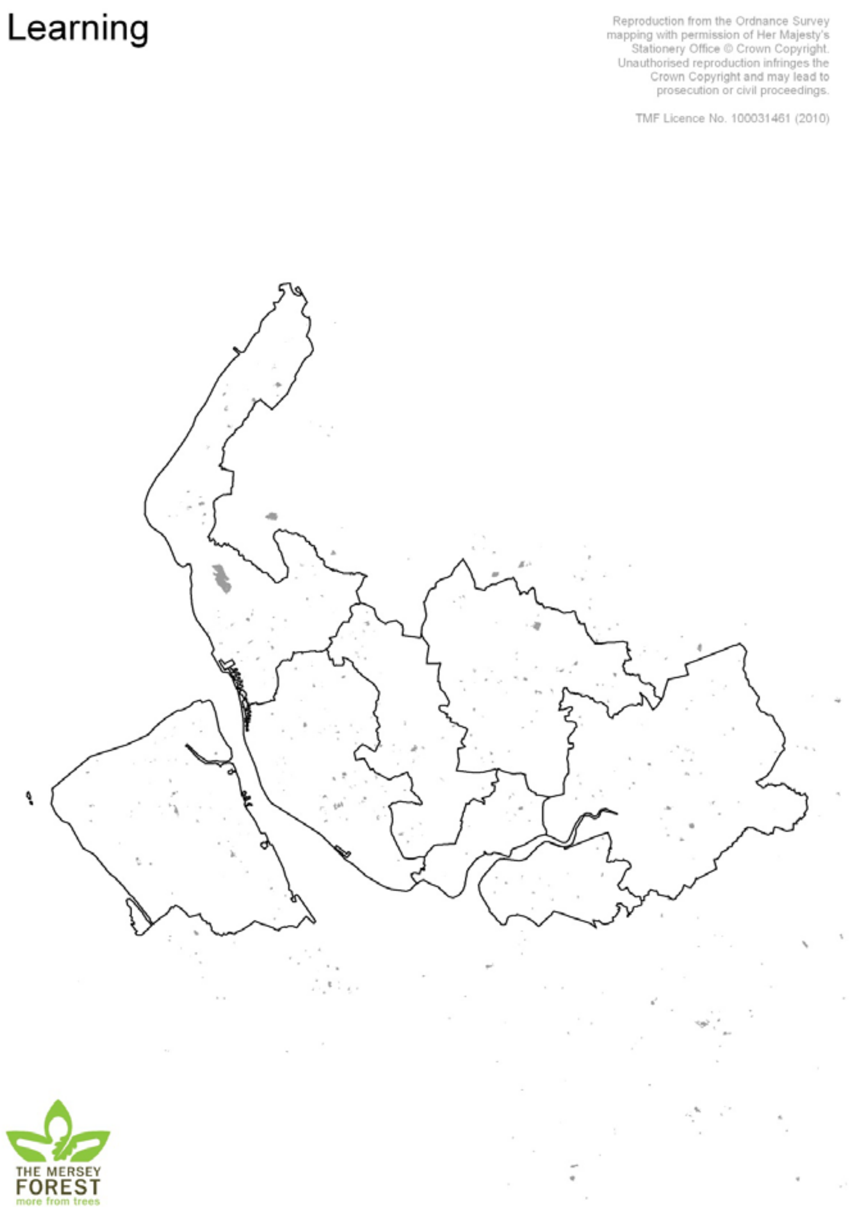


Figure 59 Noise absorption

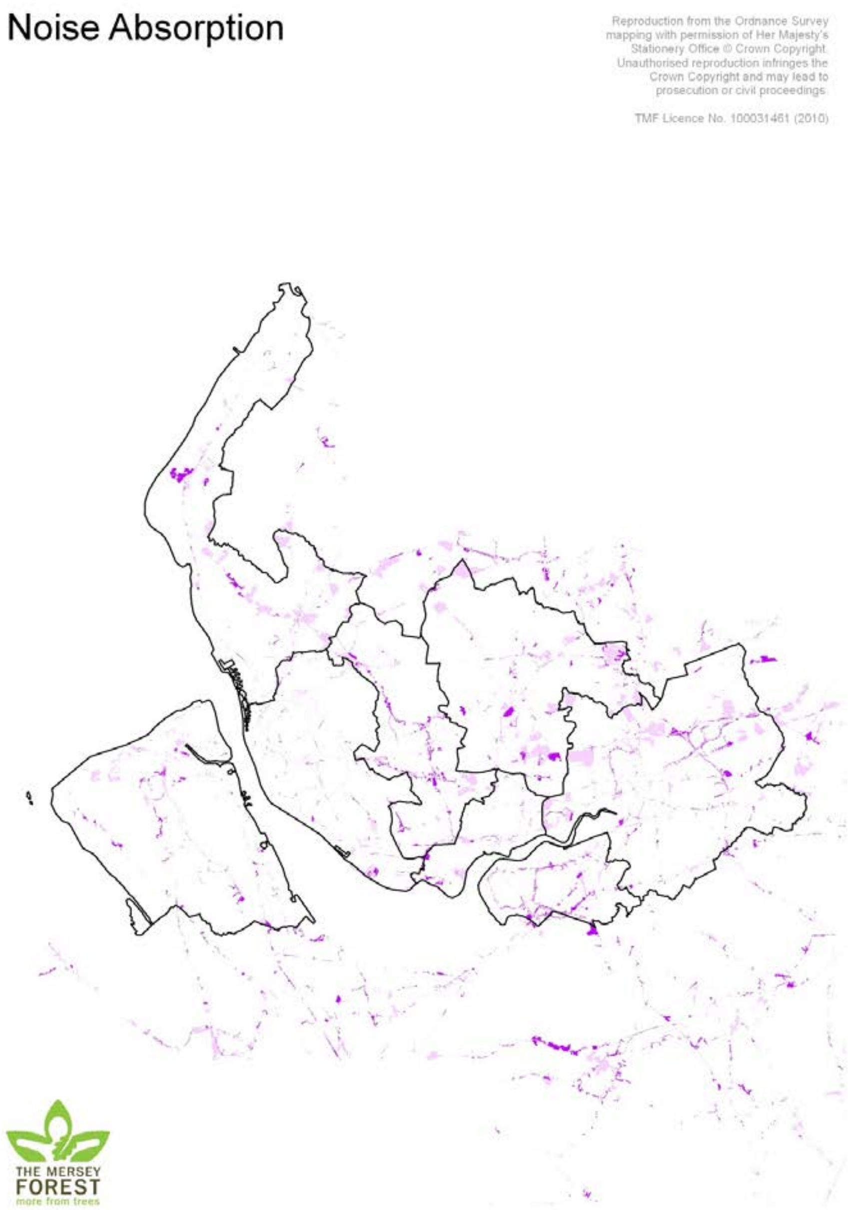


Figure 60 Pollutant removal from soil/water

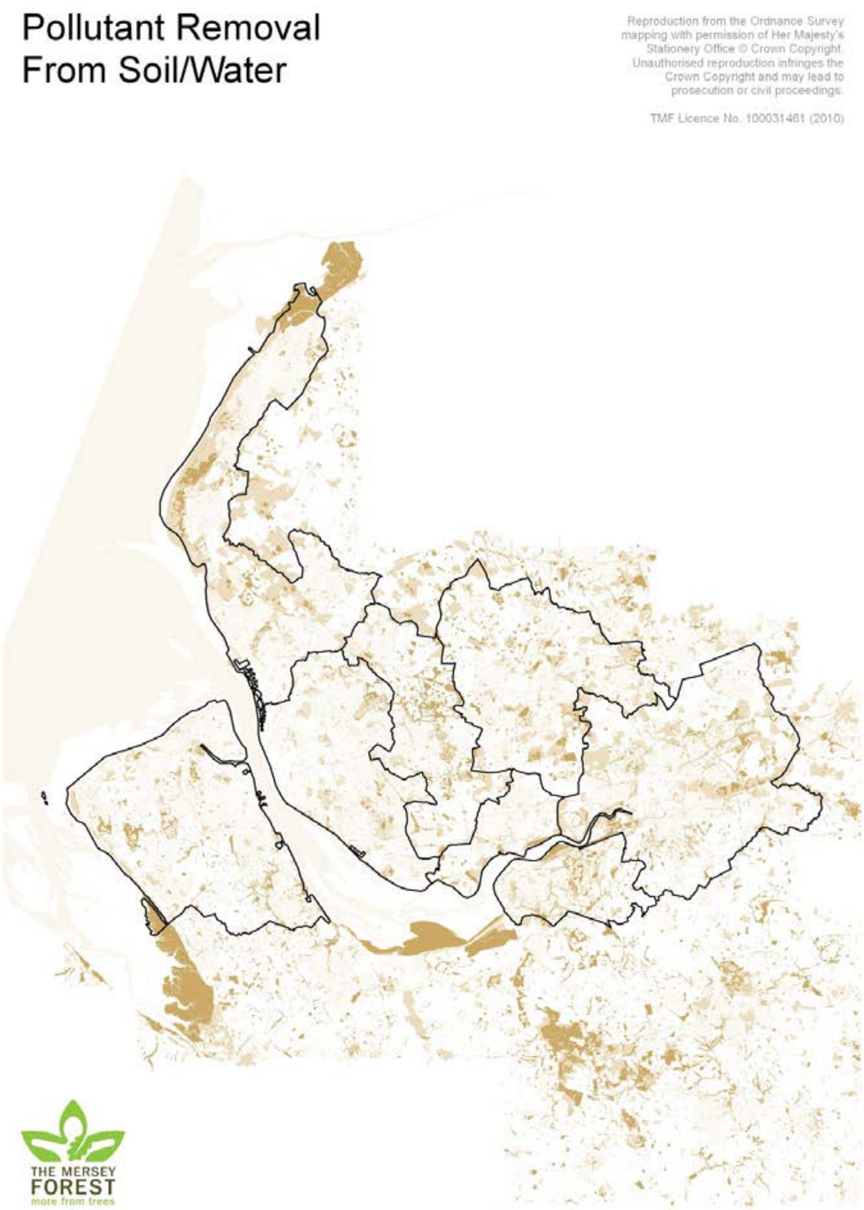


Figure 61 Recreation - private

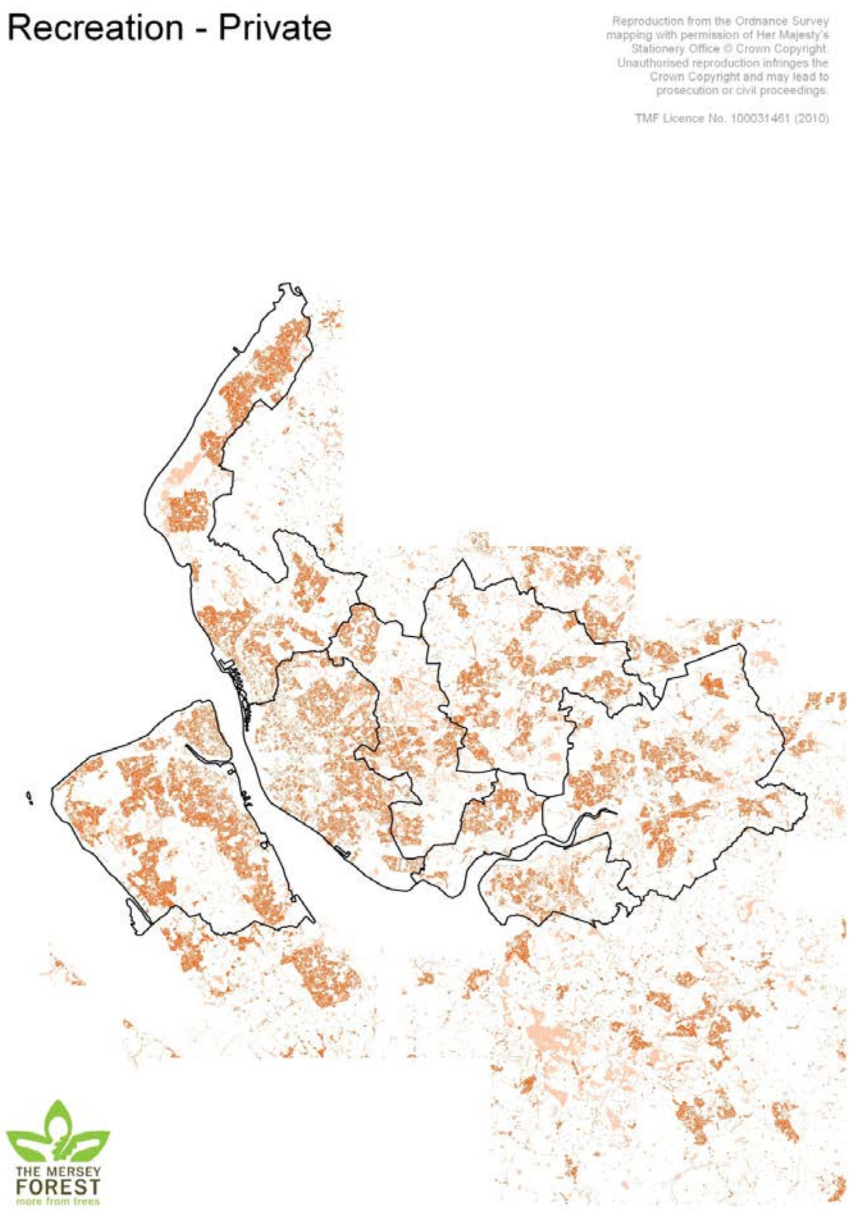


Figure 62 Recreation - public

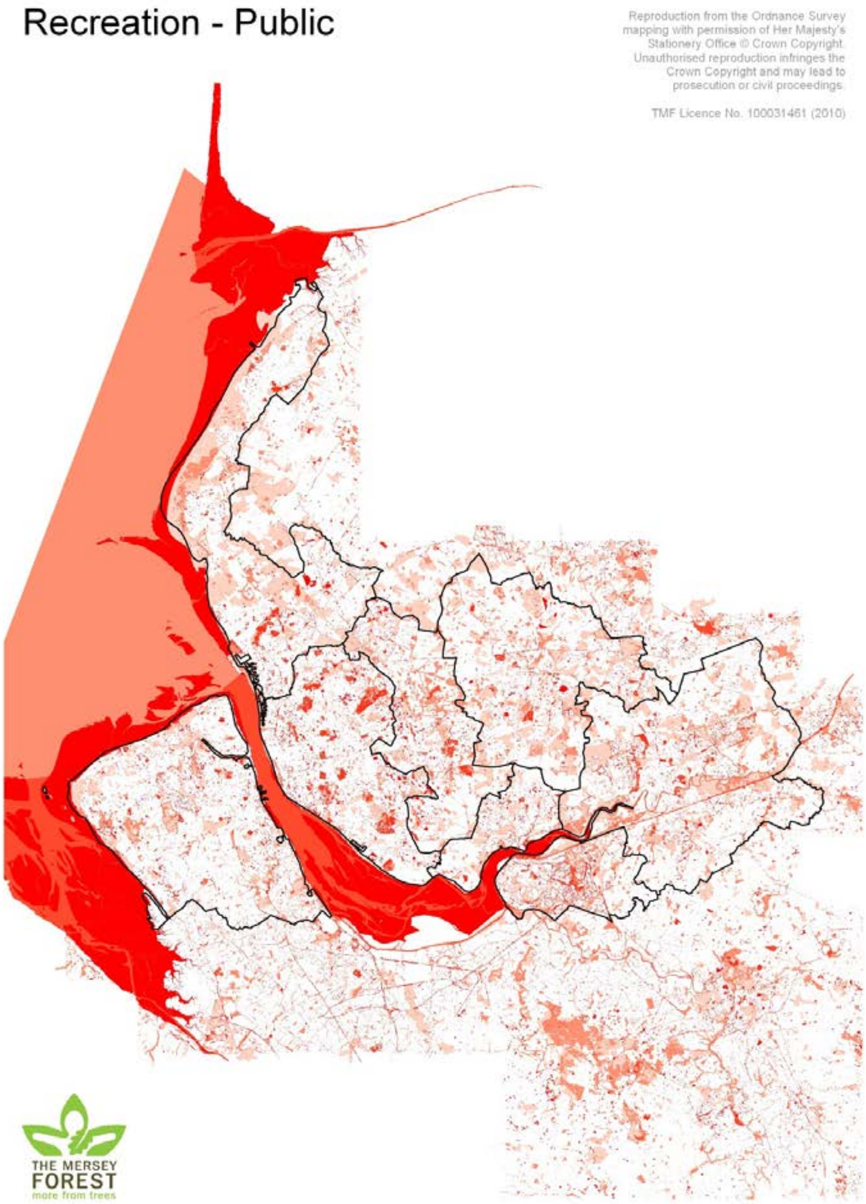


Figure 63 Recreation - public with restrictions

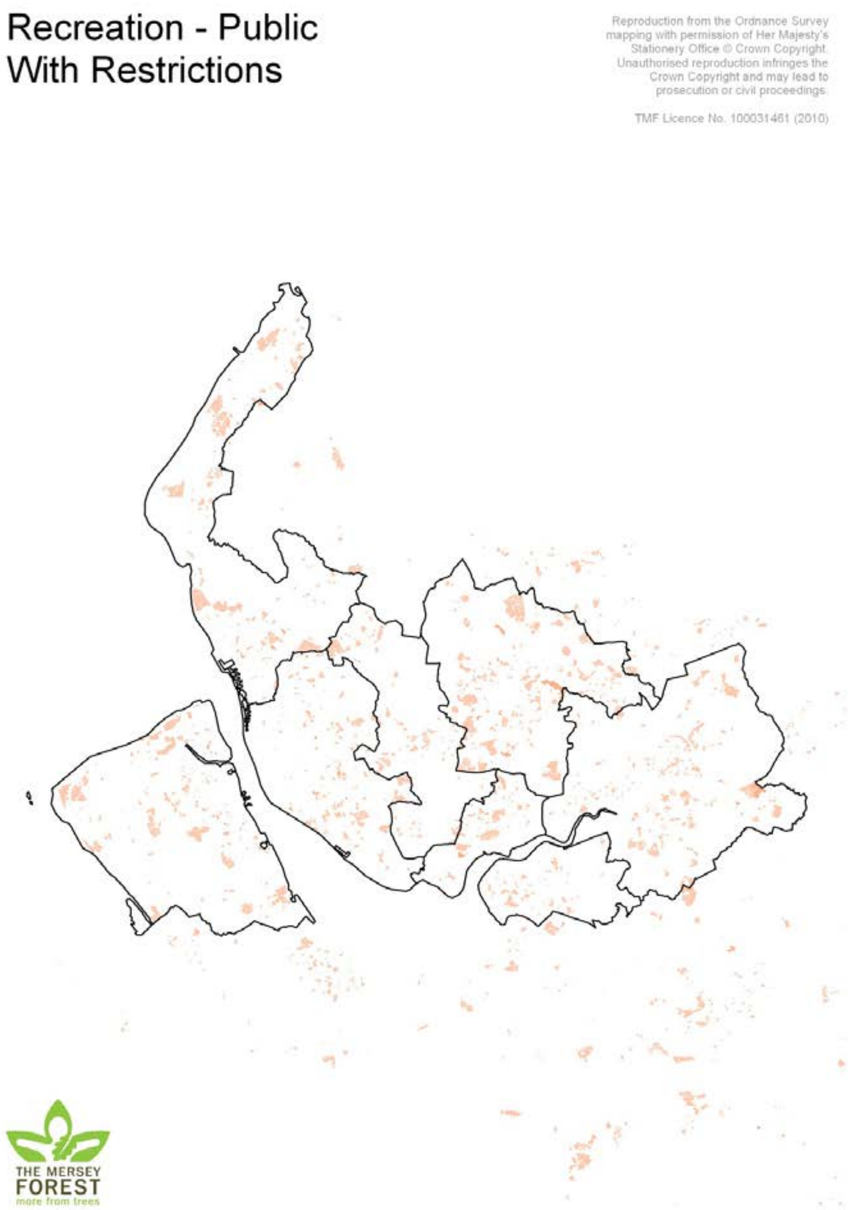


Figure 64 Shading from the sun

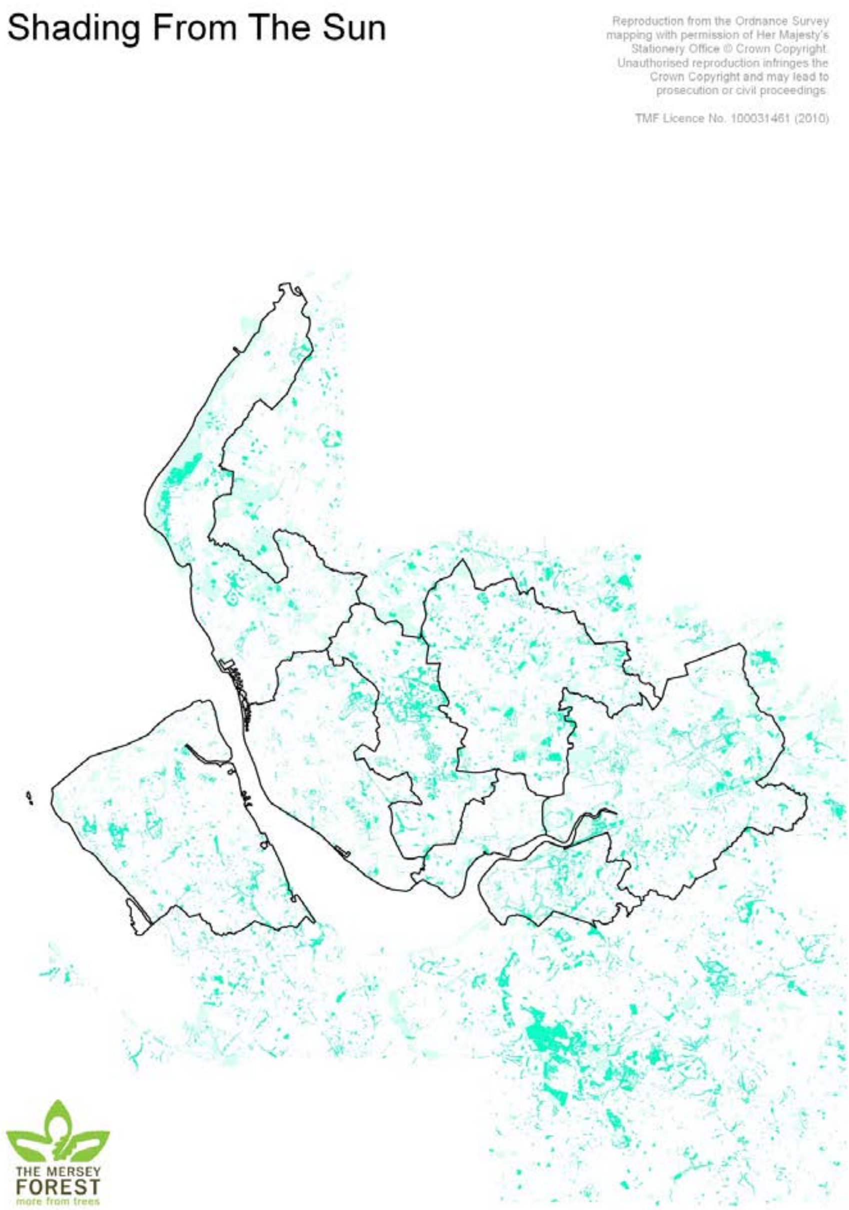


Figure 65 Soil stabilisation

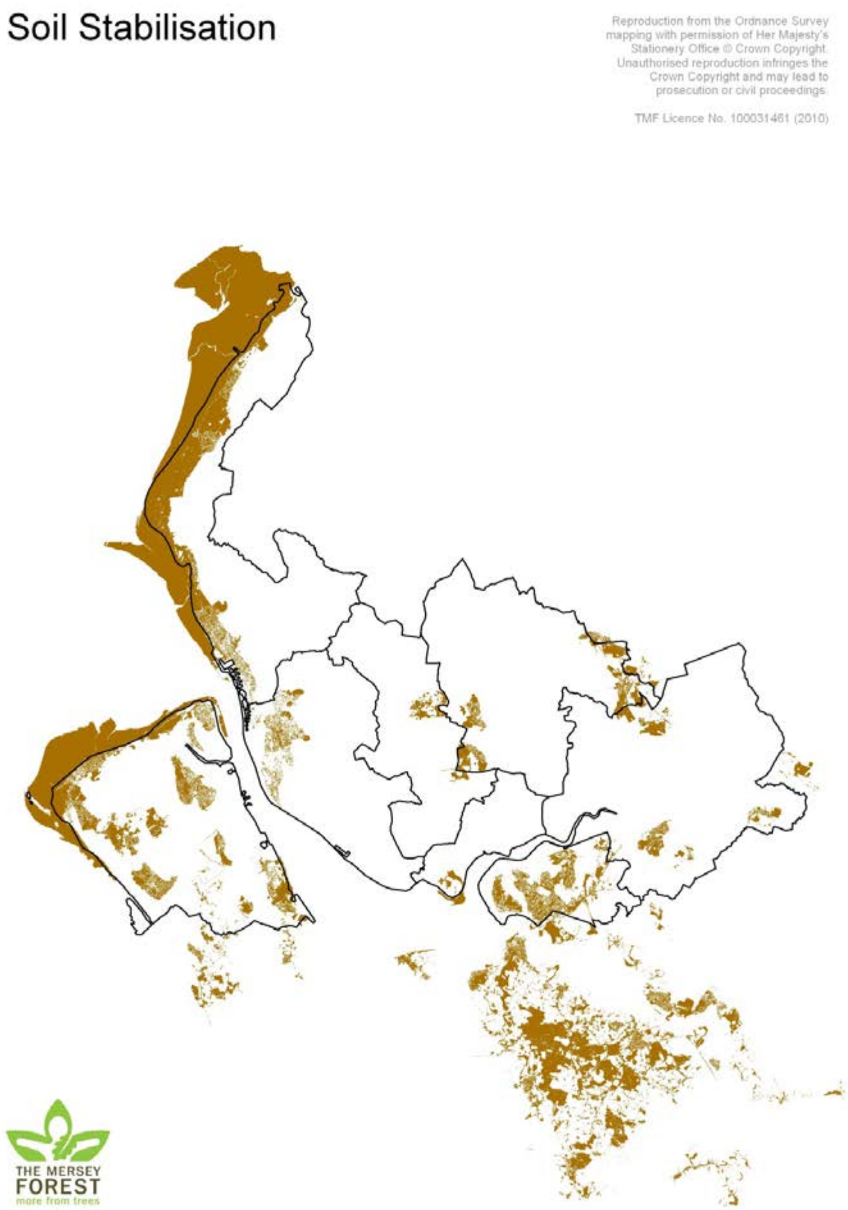


Figure 66 Timber production

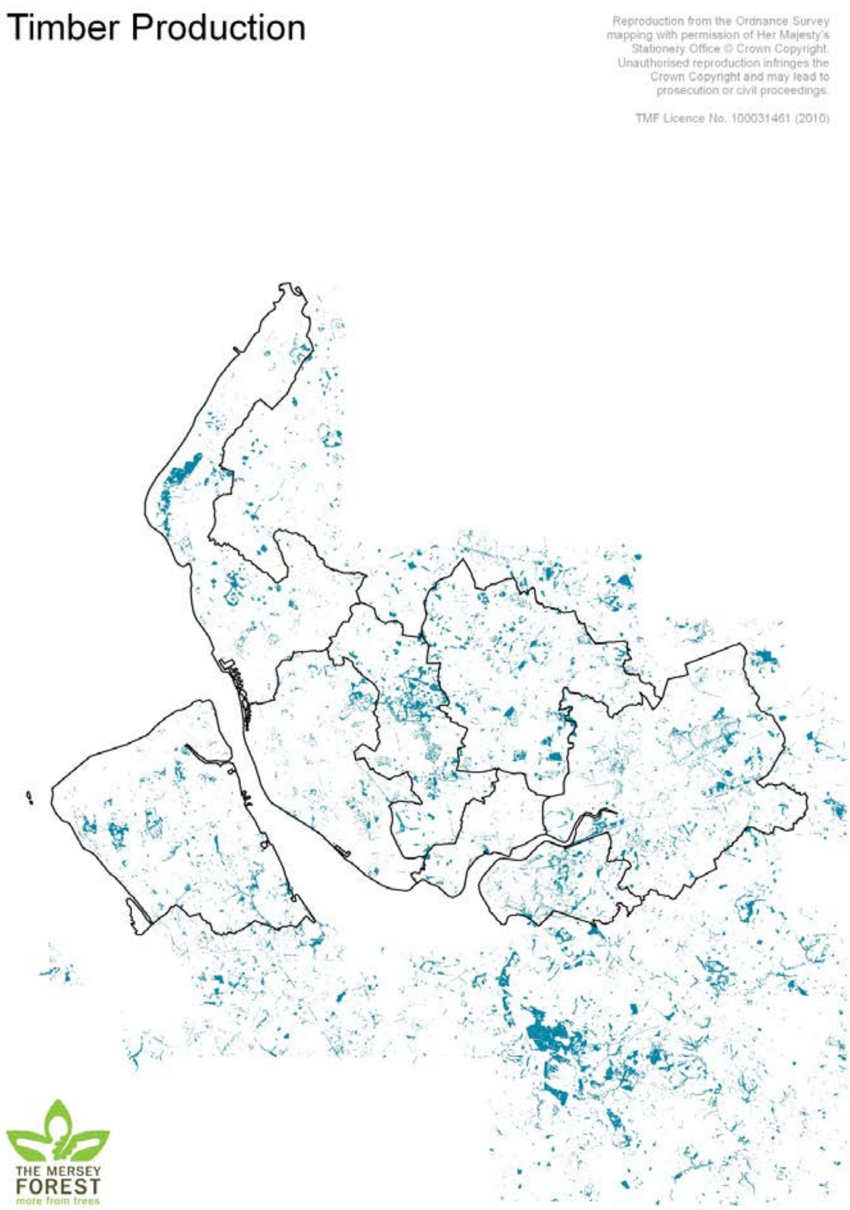


Figure 67 Trapping air pollutants

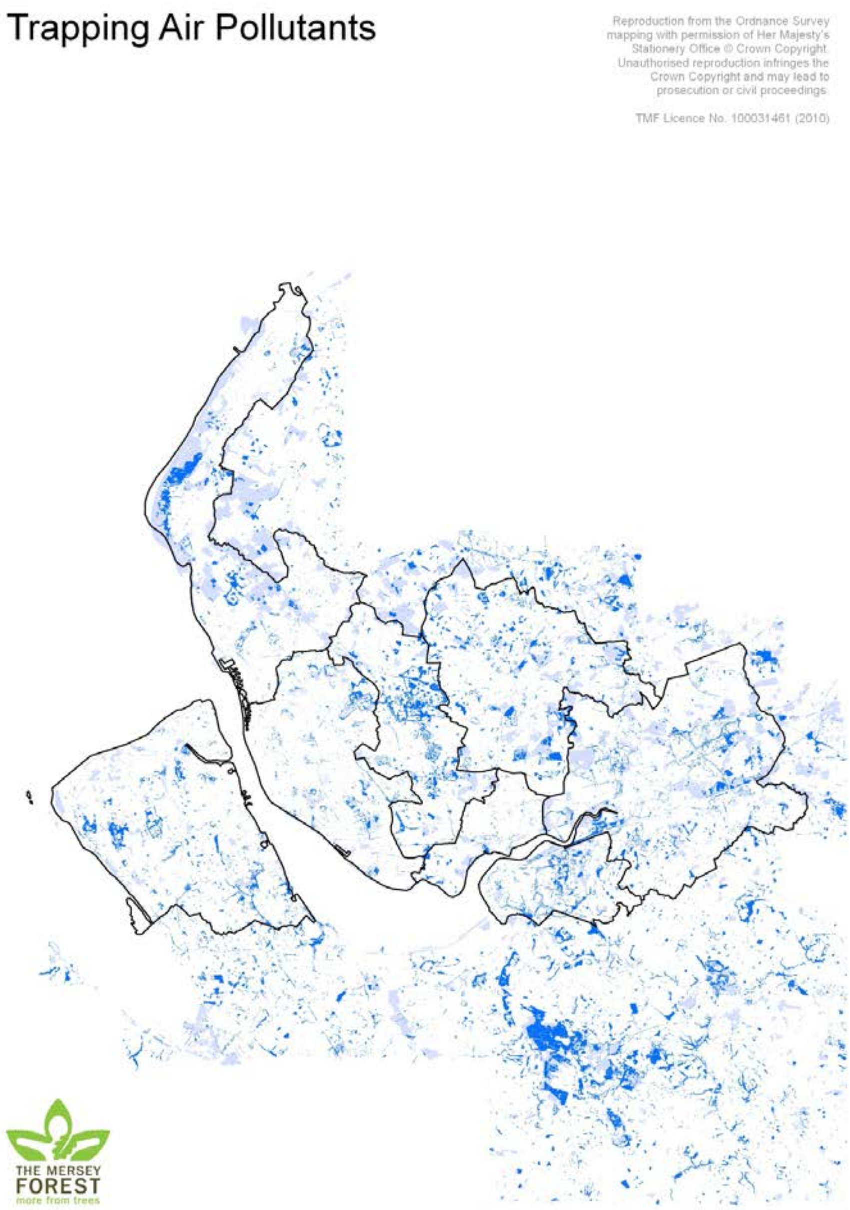


Figure 68 Water conveyance

Figure 69 Water infiltration

Figure 70 Water interception

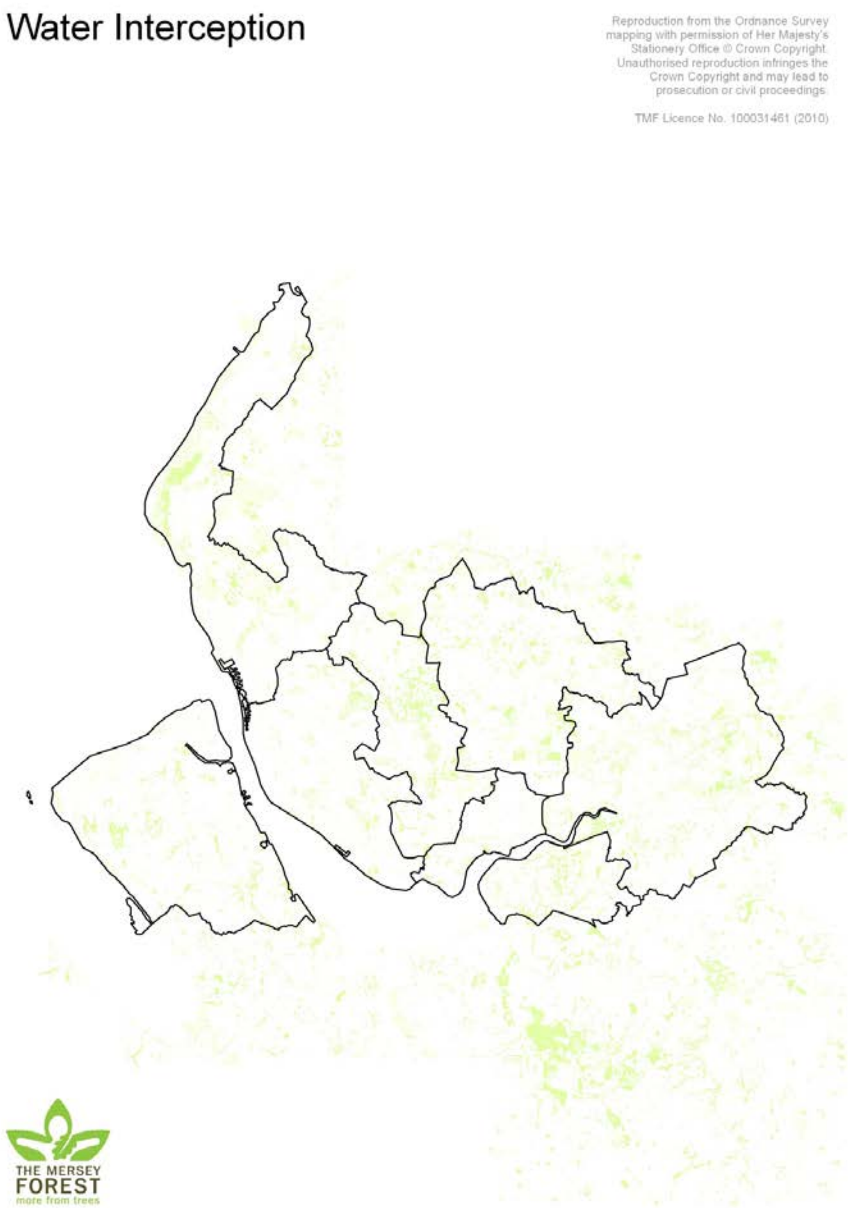
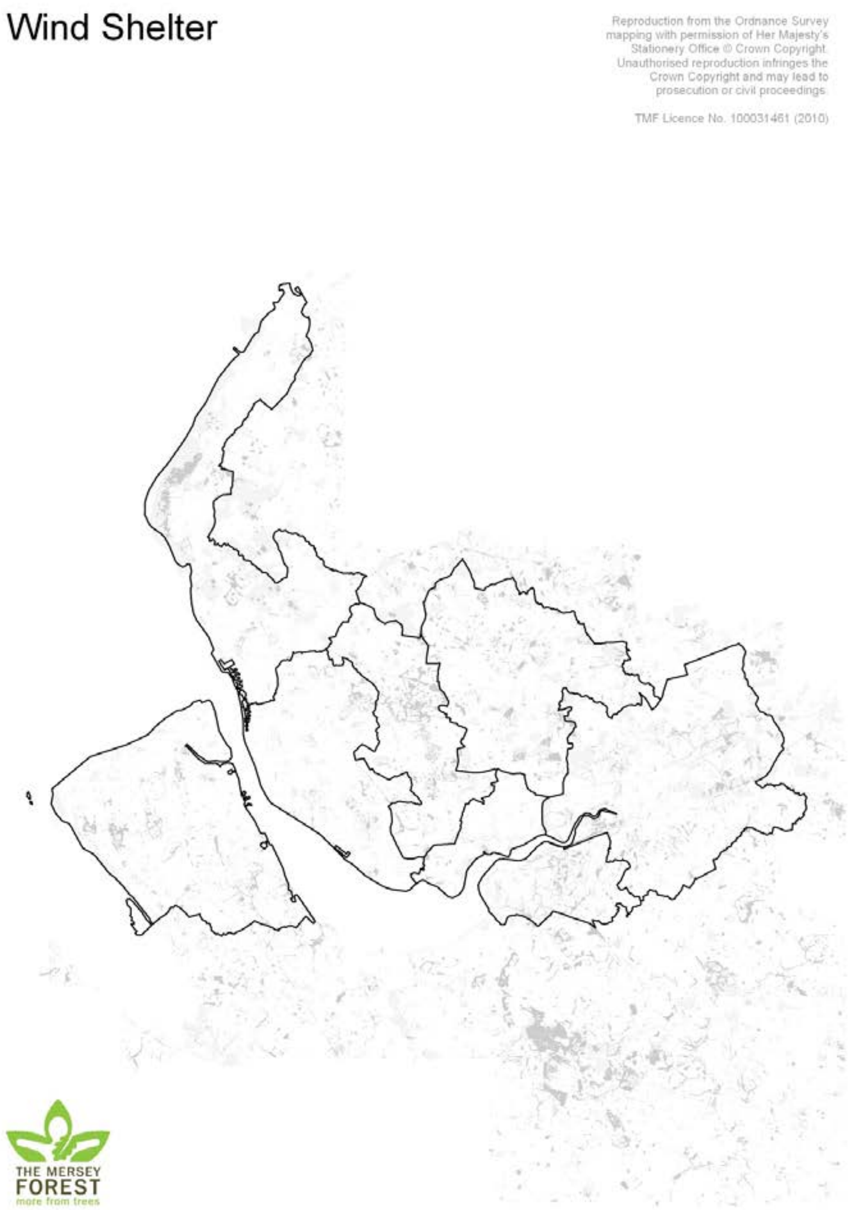


Figure 71 Wind shelter



15. Multifunctionality maps

Figure 72 Total multifunctionality

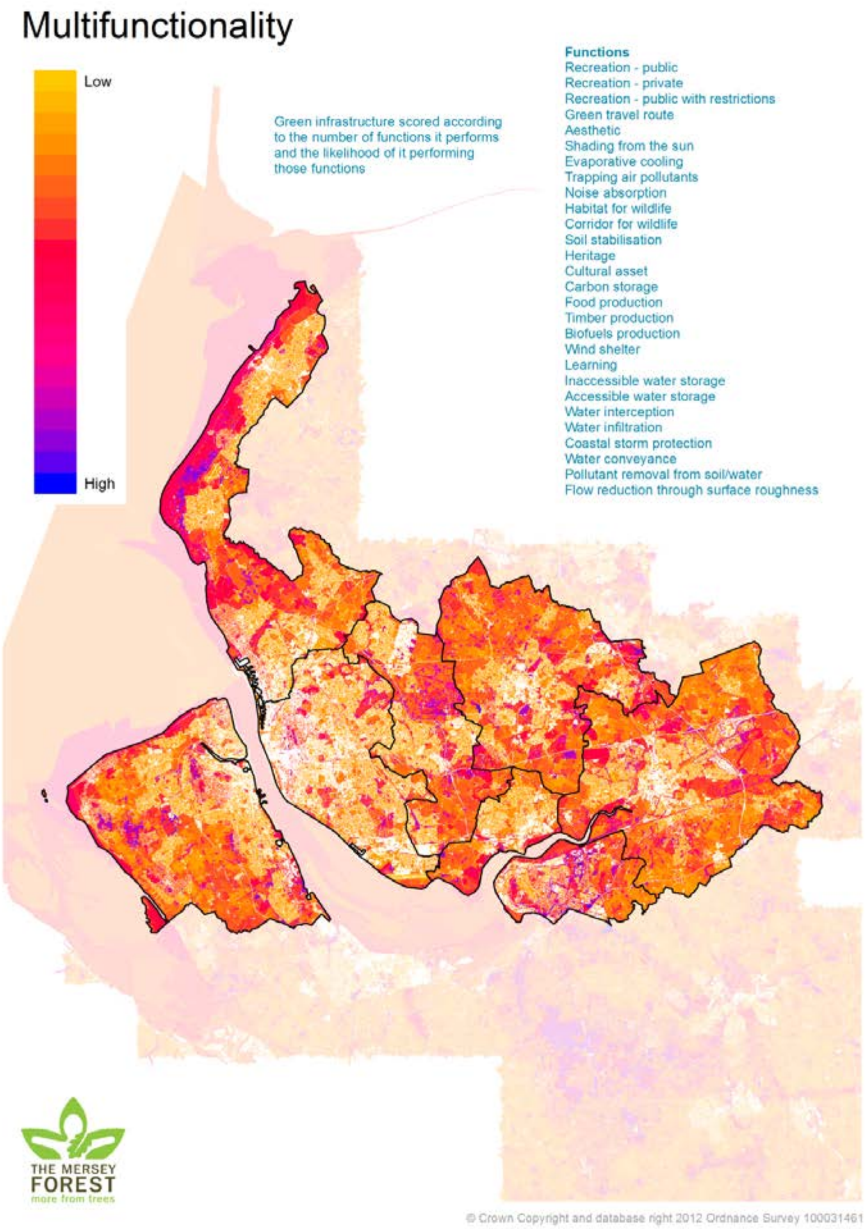


Figure 73 Developing the Rural Economy

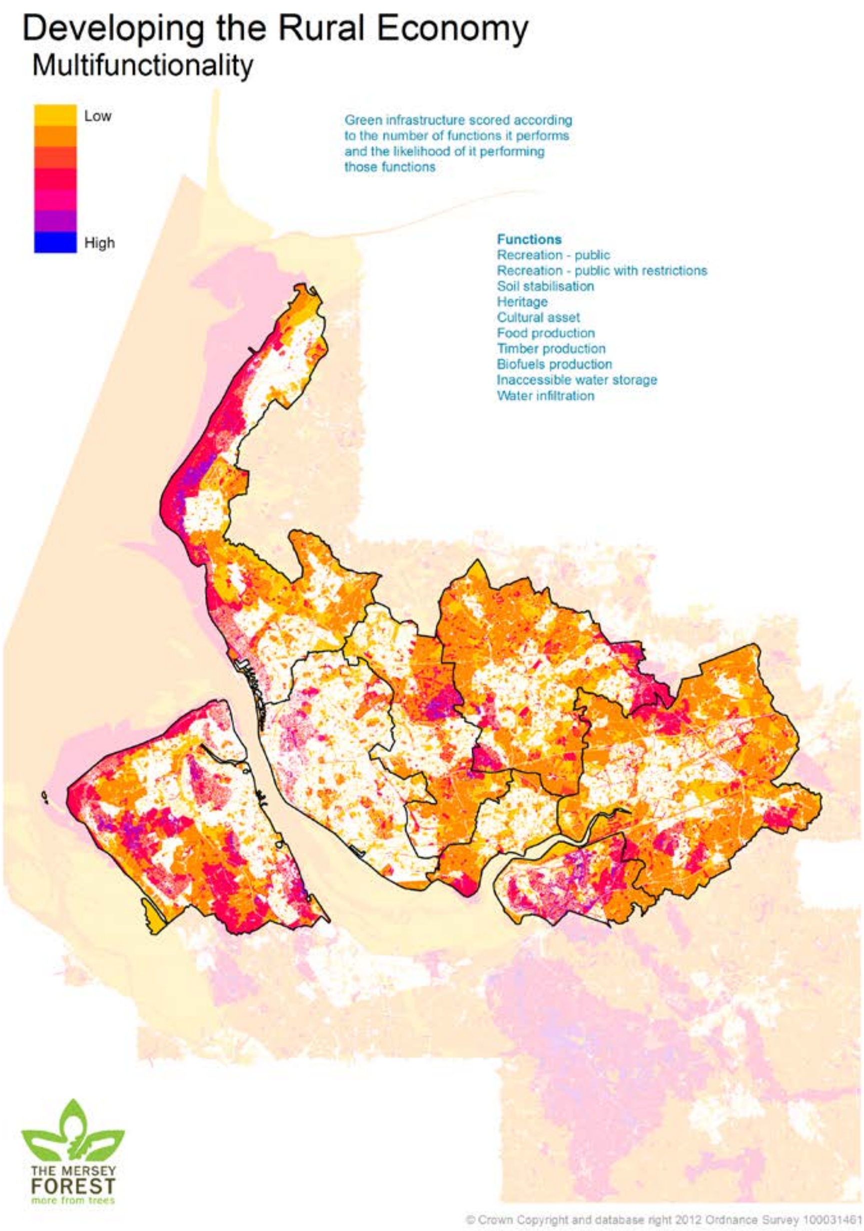


Figure 74 Enhancing the Ecological Framework

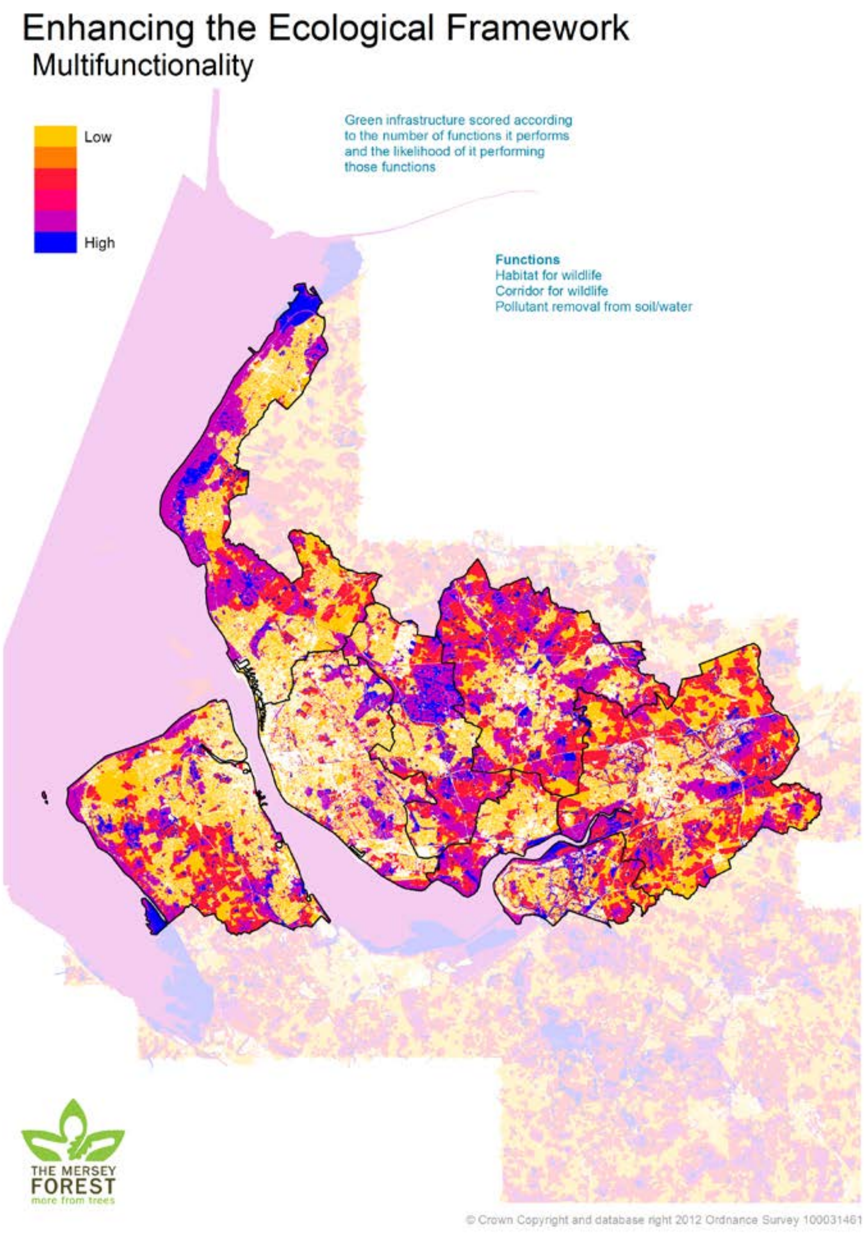


Figure 75 Providing Recreation, Leisure and Tourism

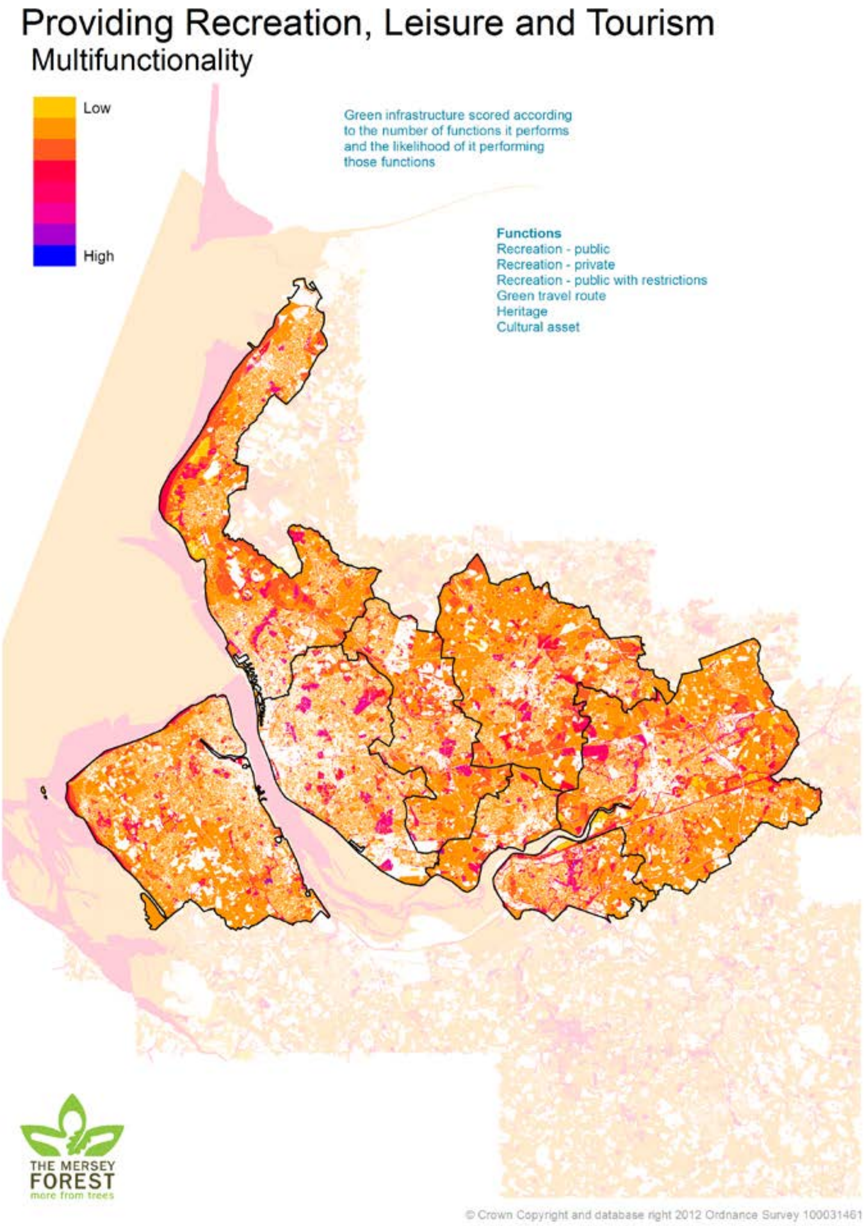


Figure 76 Setting the Scene for Growth

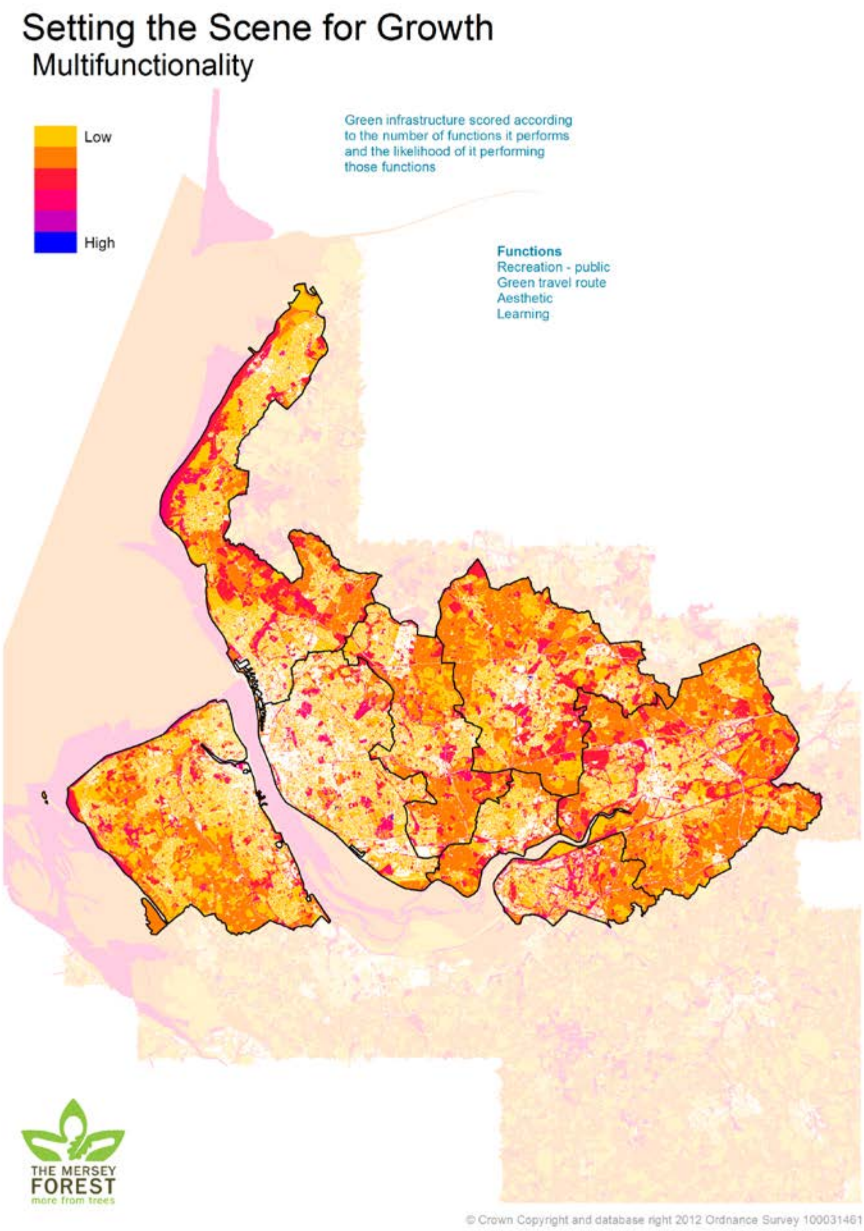


Figure 77 Supporting Adaptation to Climate Change

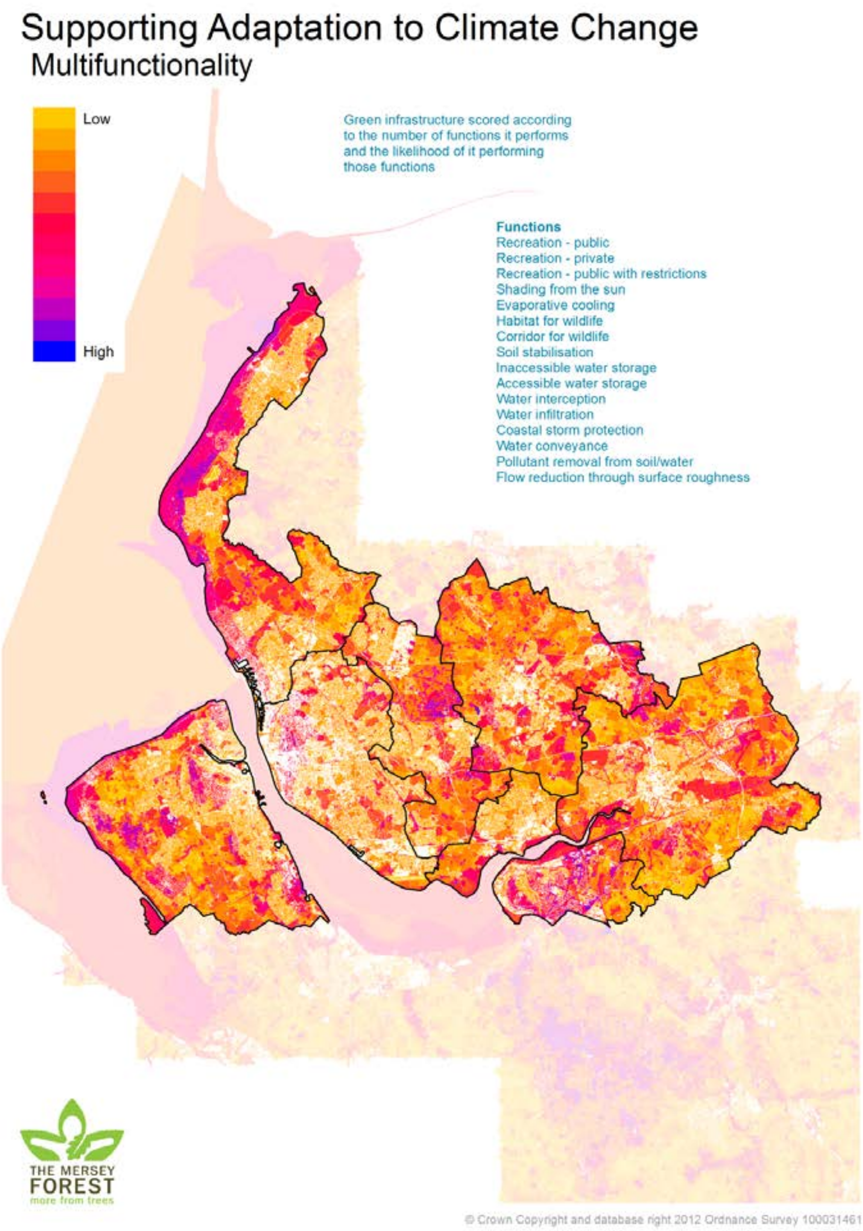
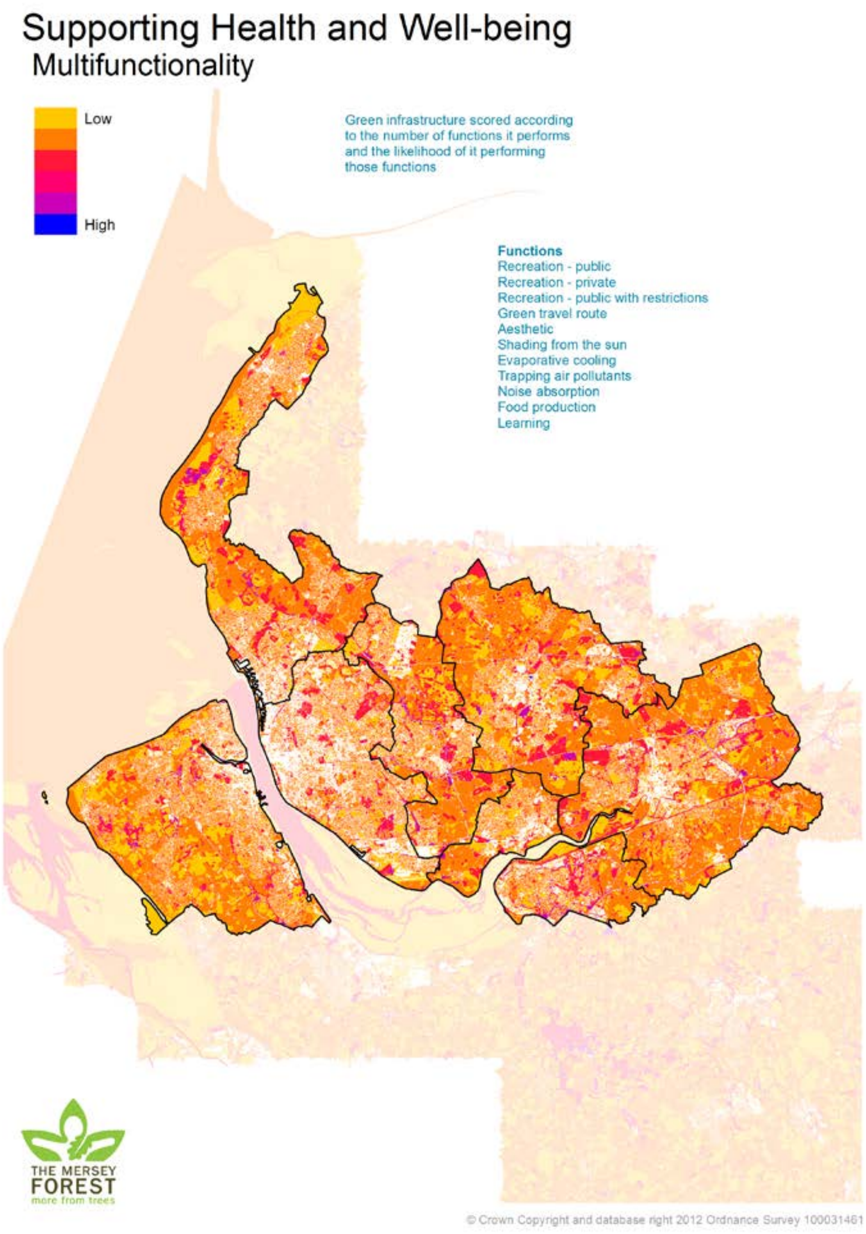


Figure 78 Supporting Health and Well-being



16. Needs mapping

Figure 79 Accessible water storage

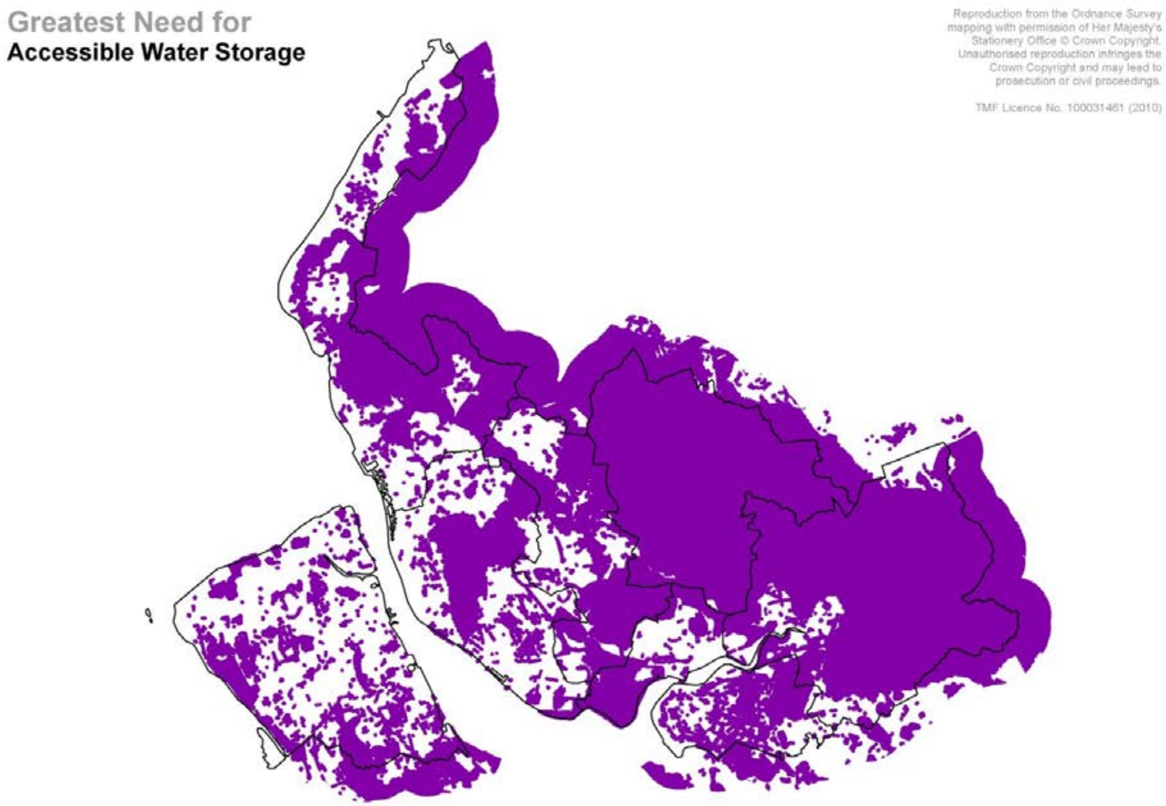


Figure 80 Aesthetic

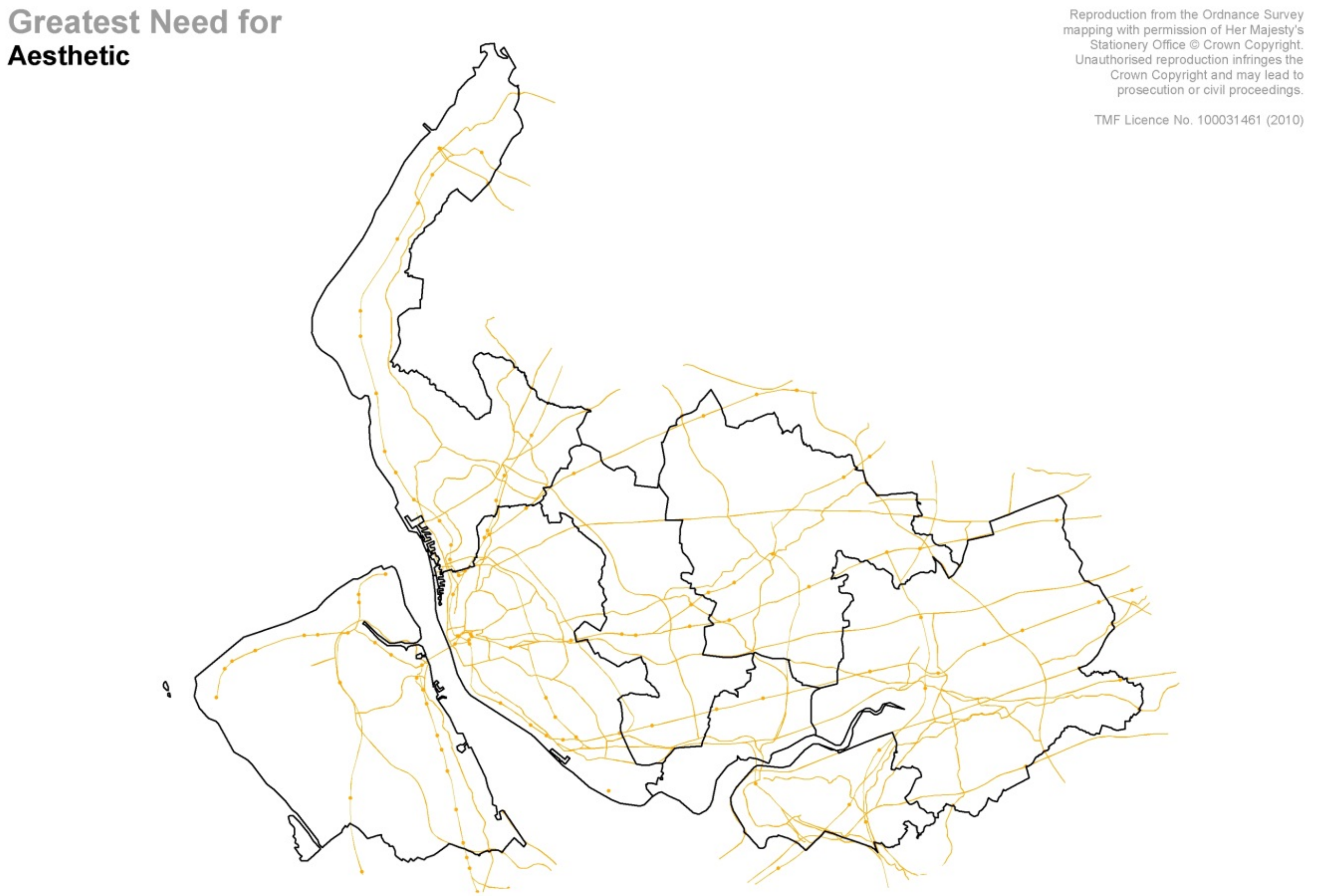


Figure 81 Biofuels production

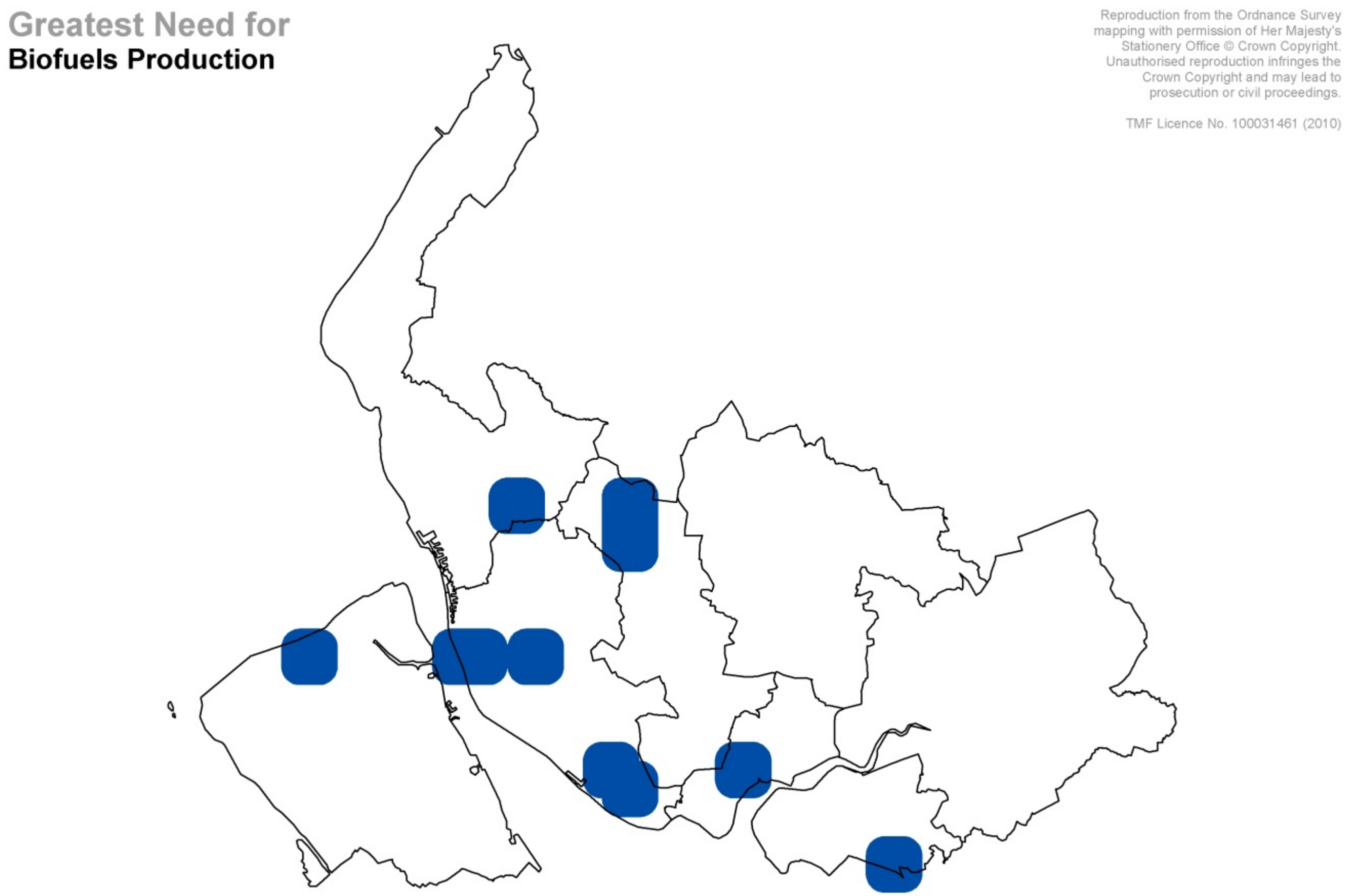


Figure 82 Carbon storage

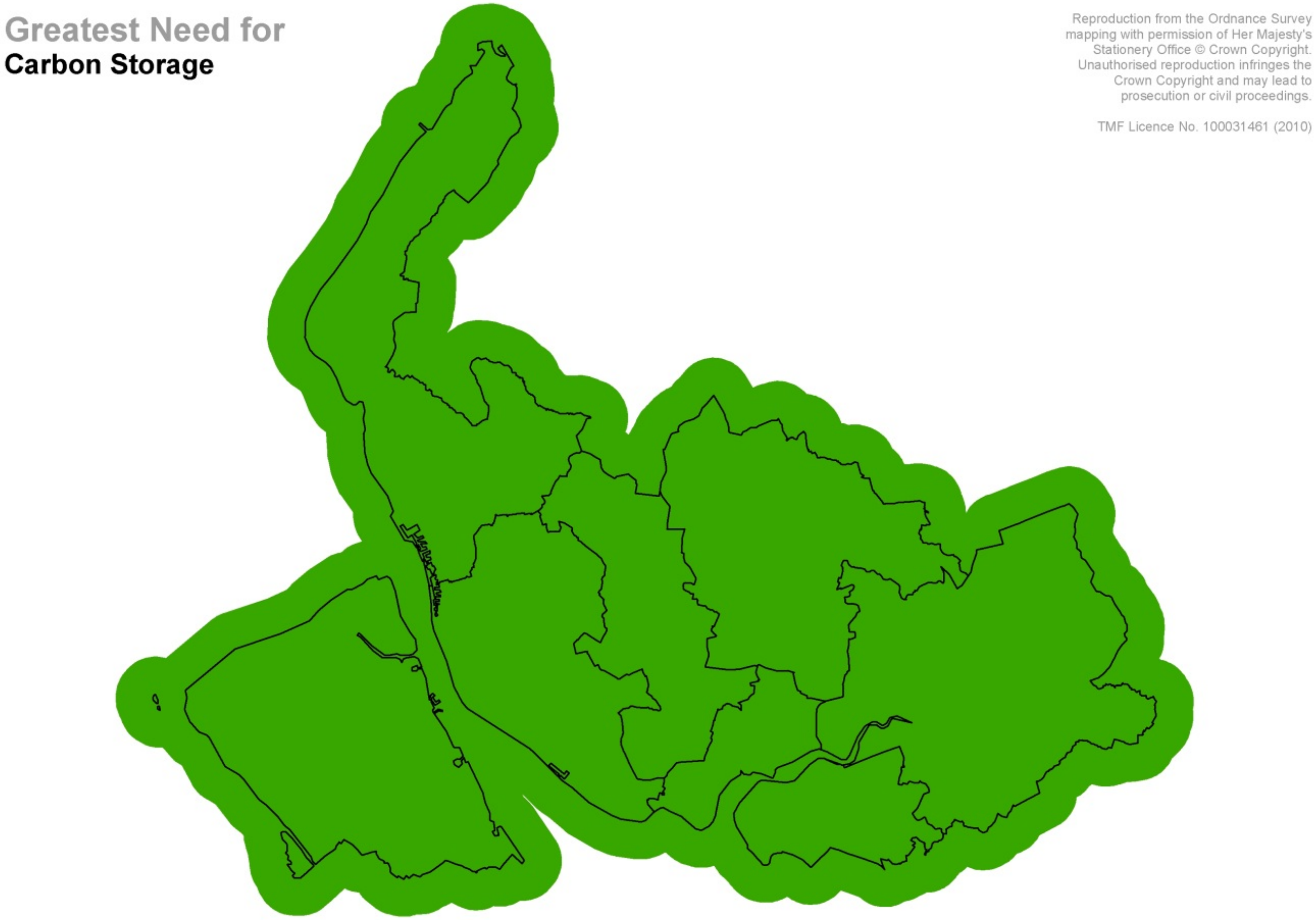


Figure 83 Coastal storm protection

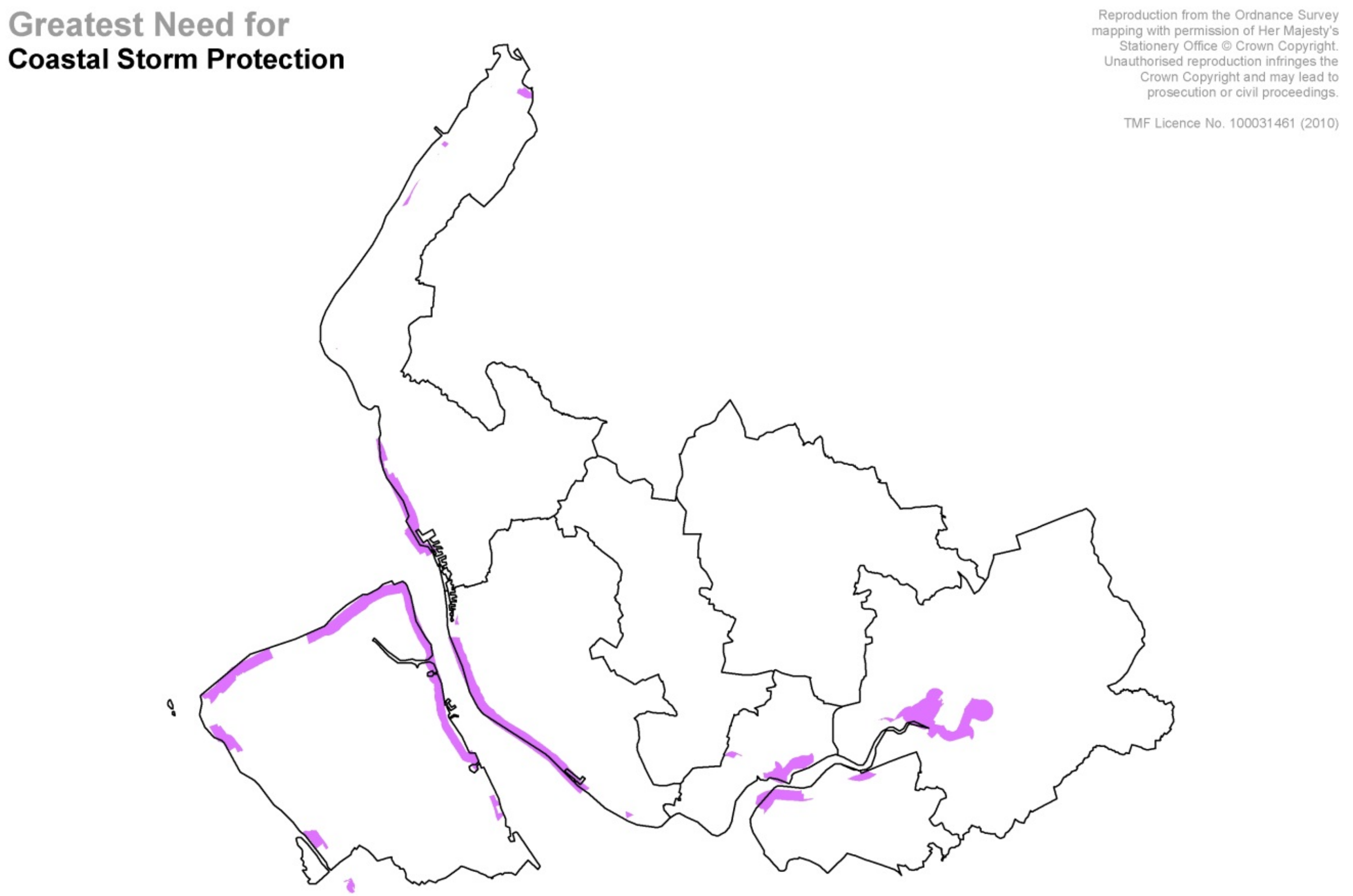
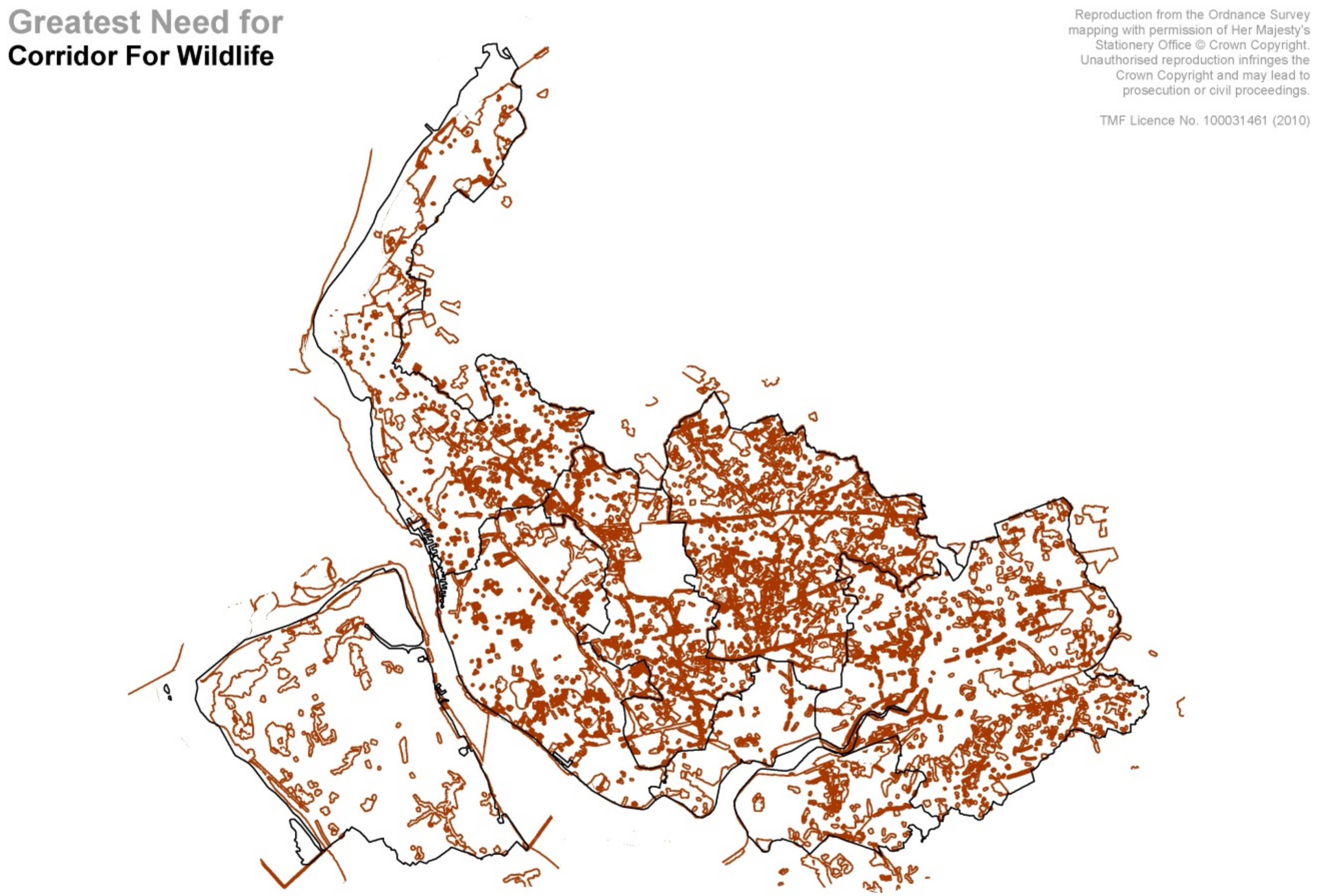


Figure 84 Corridor for wildlife



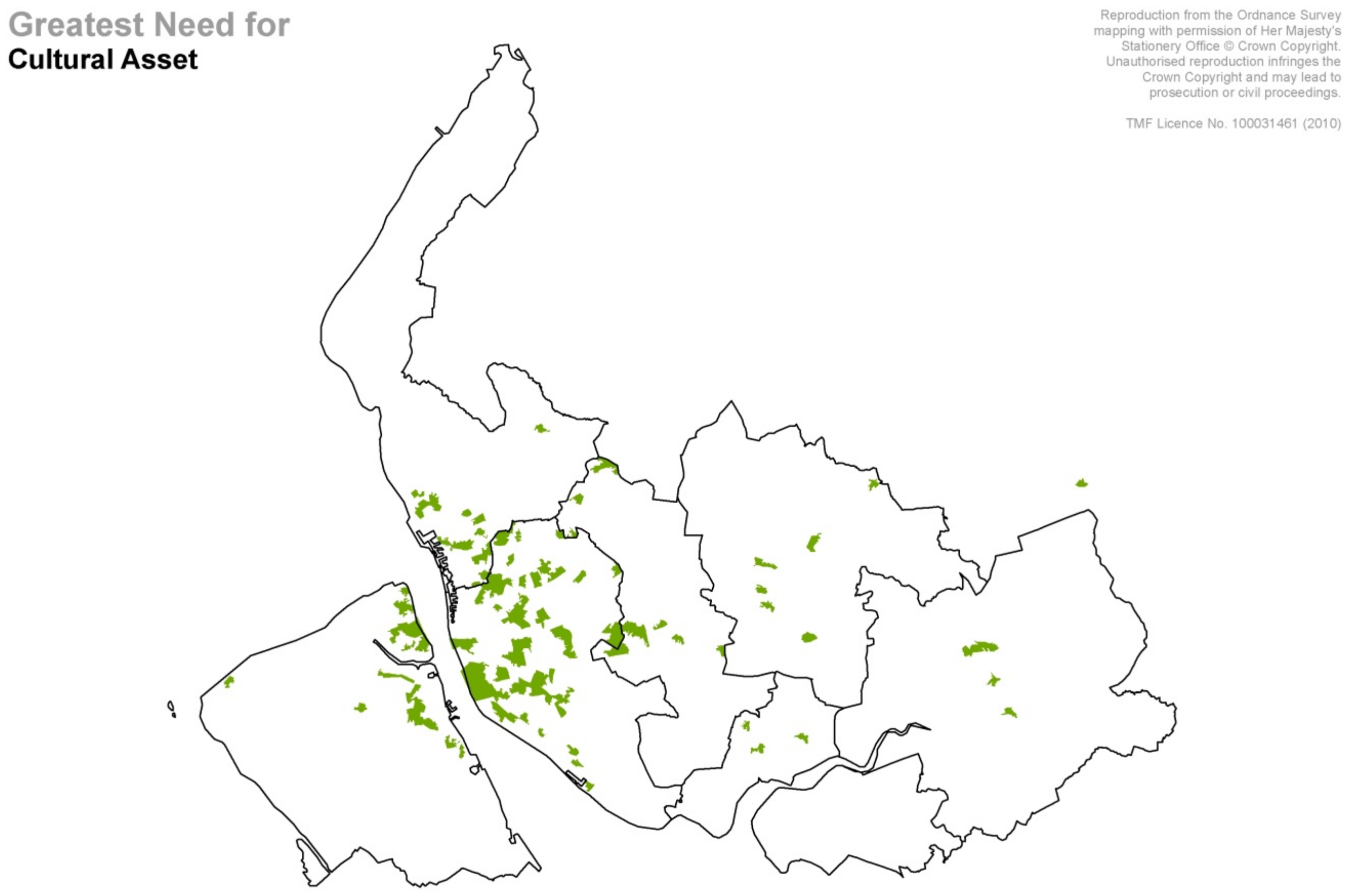


Figure 85 Cultural asset

Figure 86 Evaporative cooling

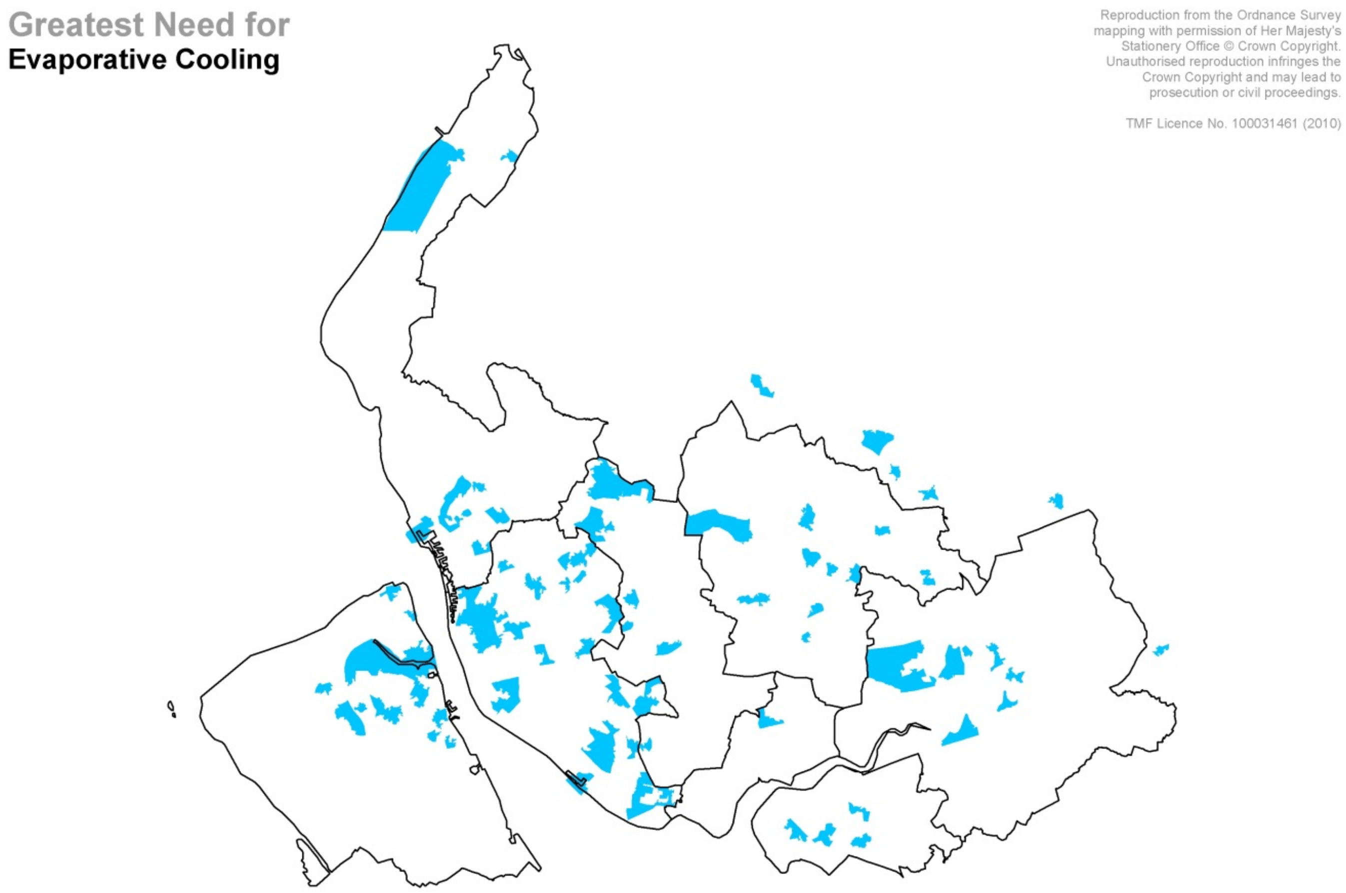


Figure 87 Flow reduction through surface roughness

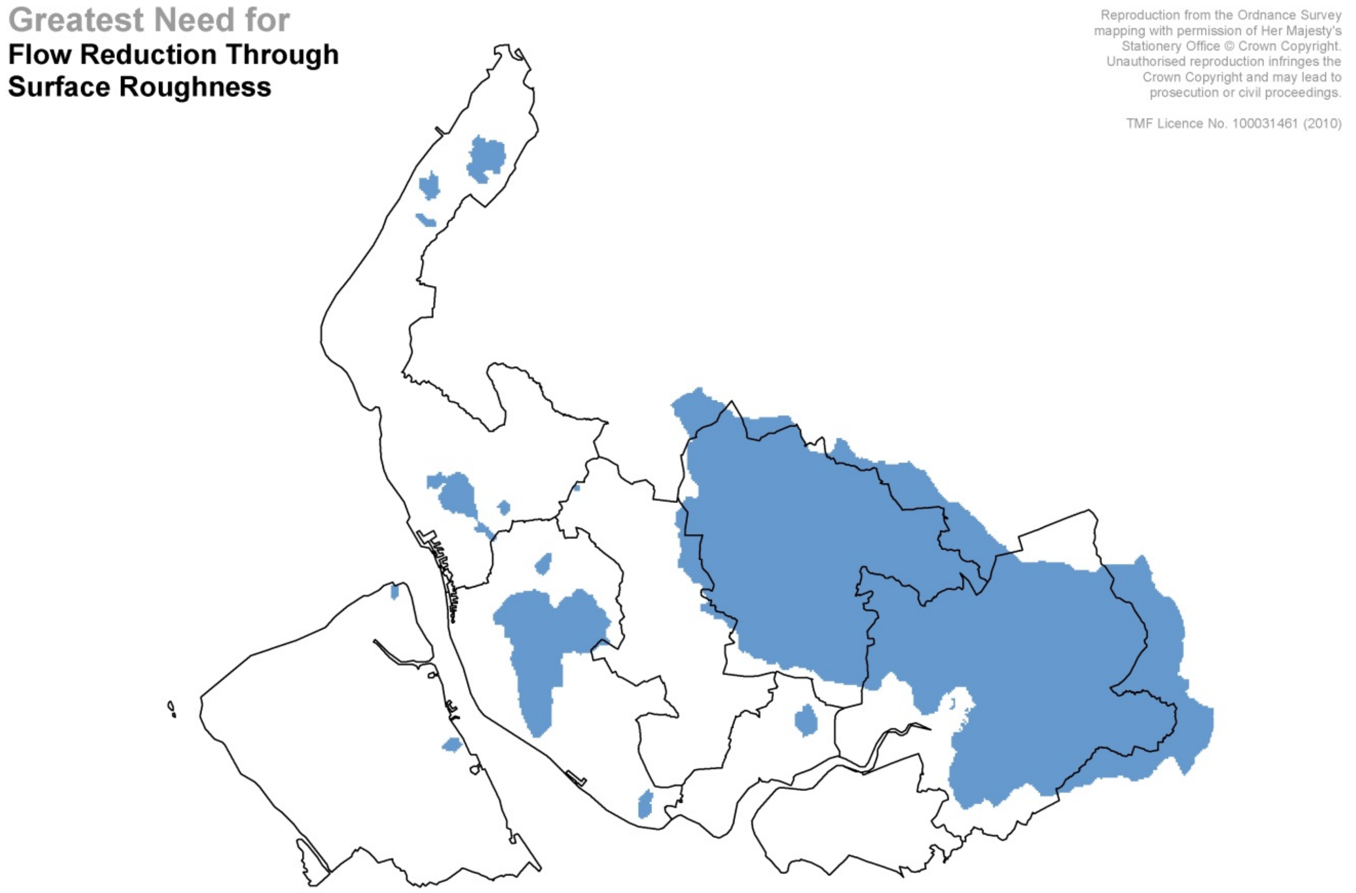


Figure 88 Food production

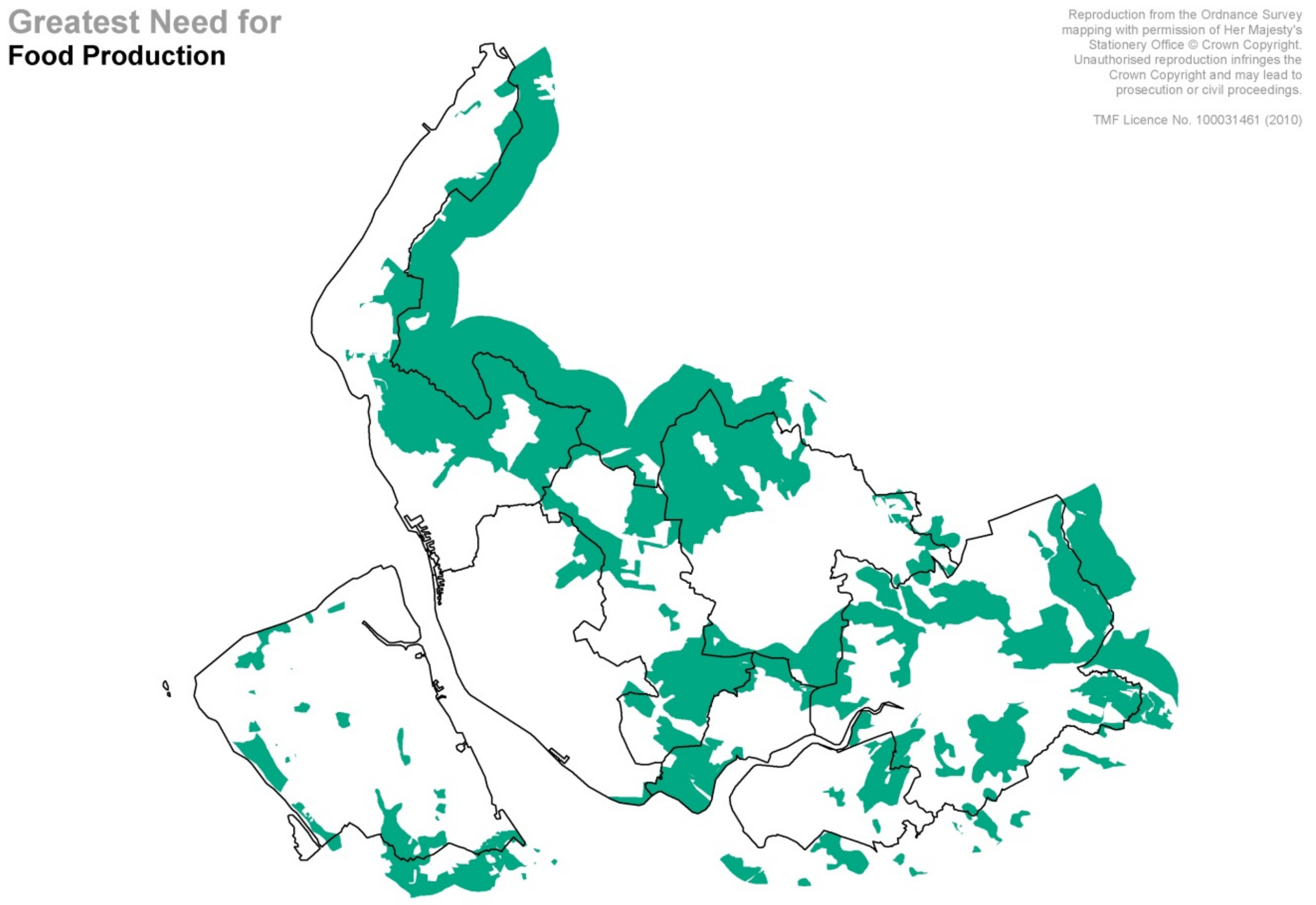


Figure 89 Green travel route

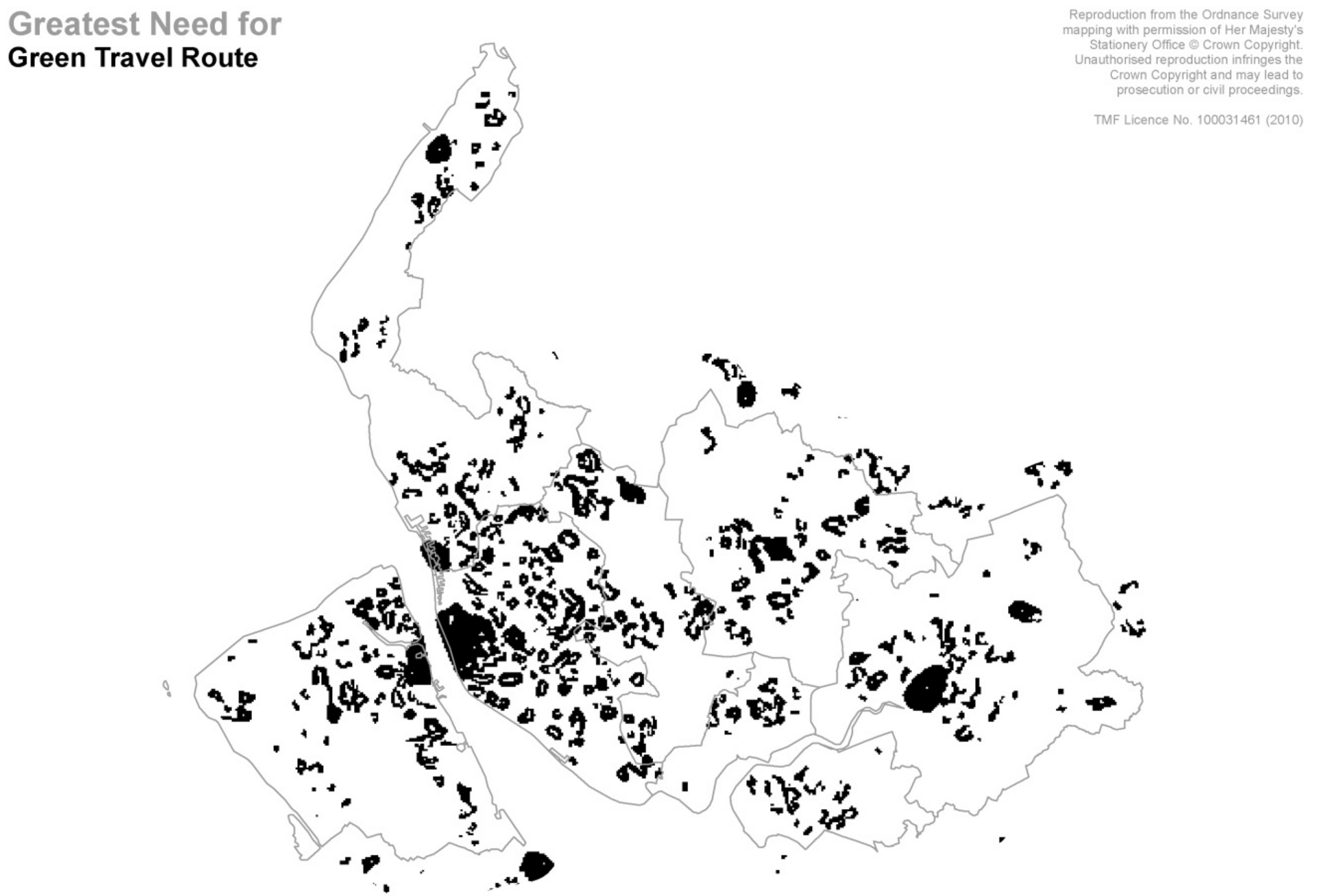


Figure 90 Habitat for wildlife

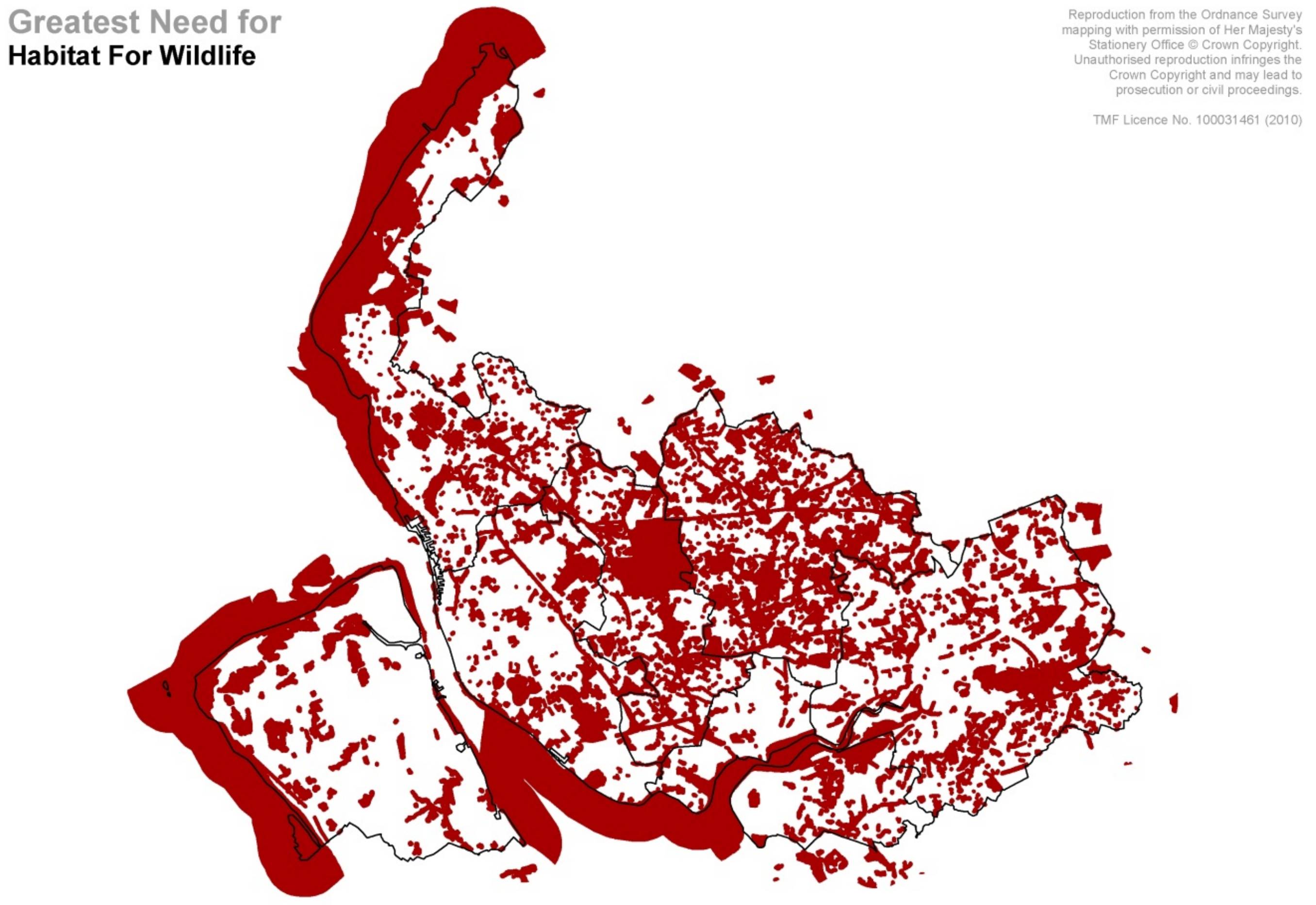


Figure 91 Heritage

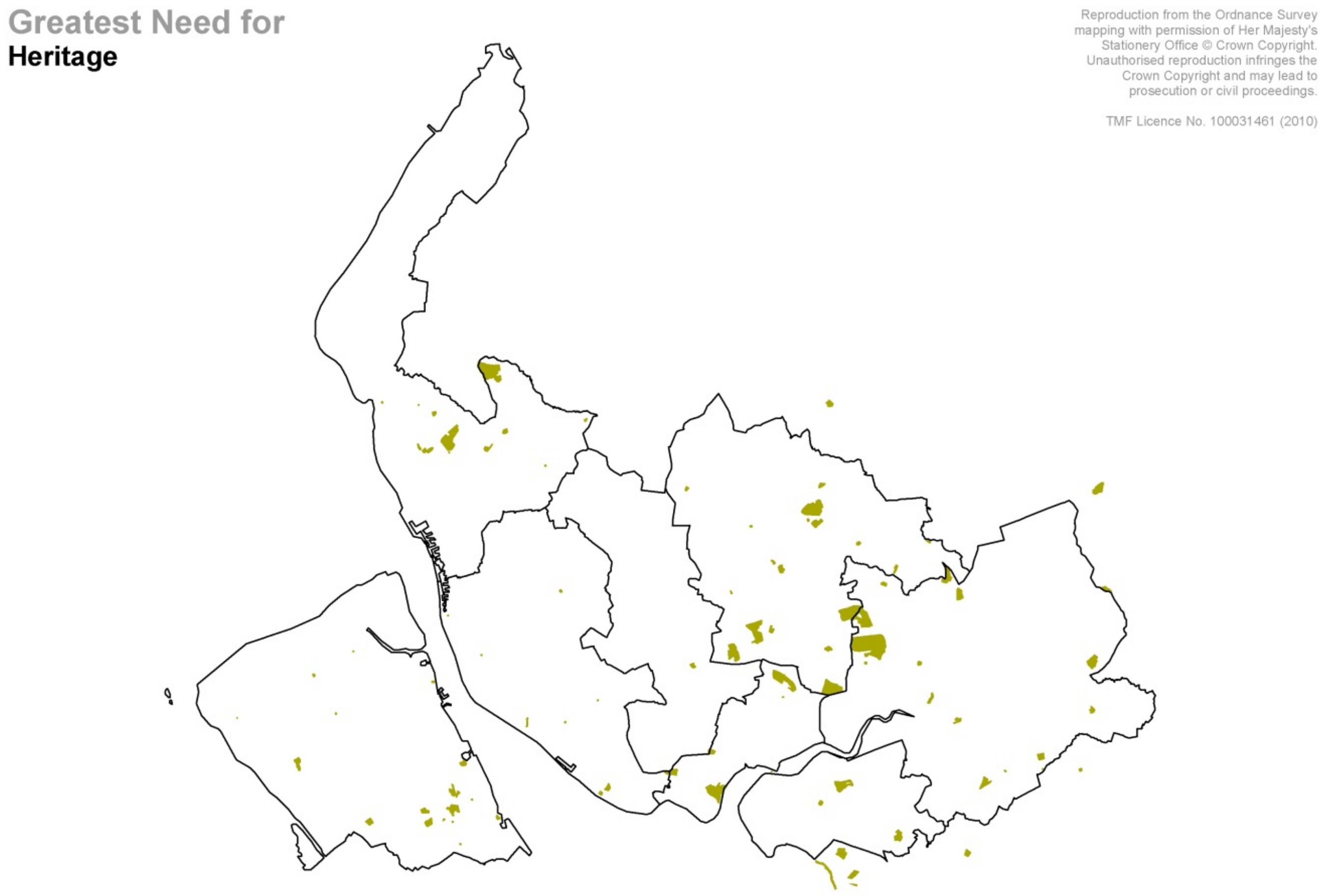


Figure 92 Inaccessible water storage

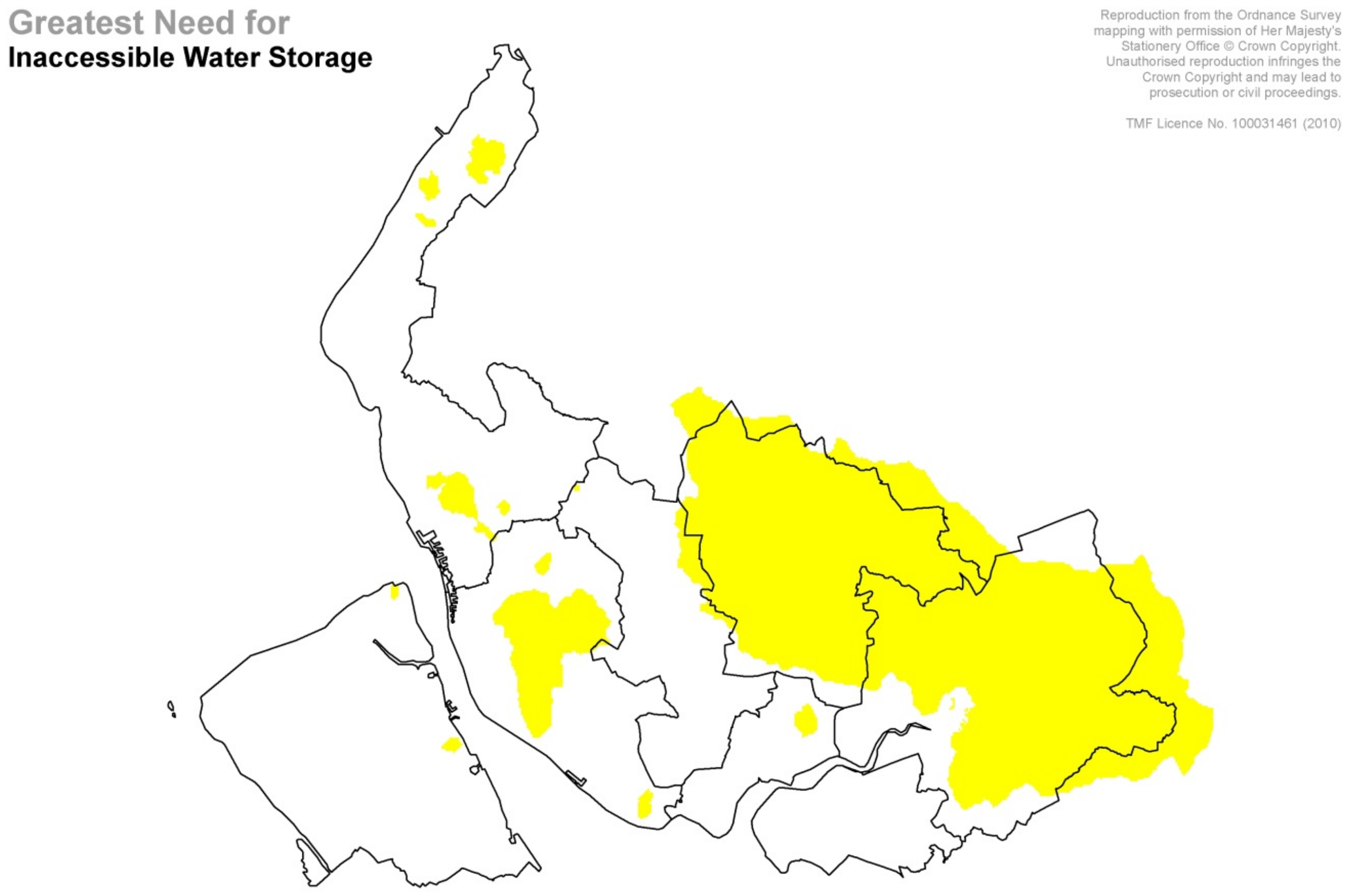


Figure 93 Learning

Figure 94 Noise absorption

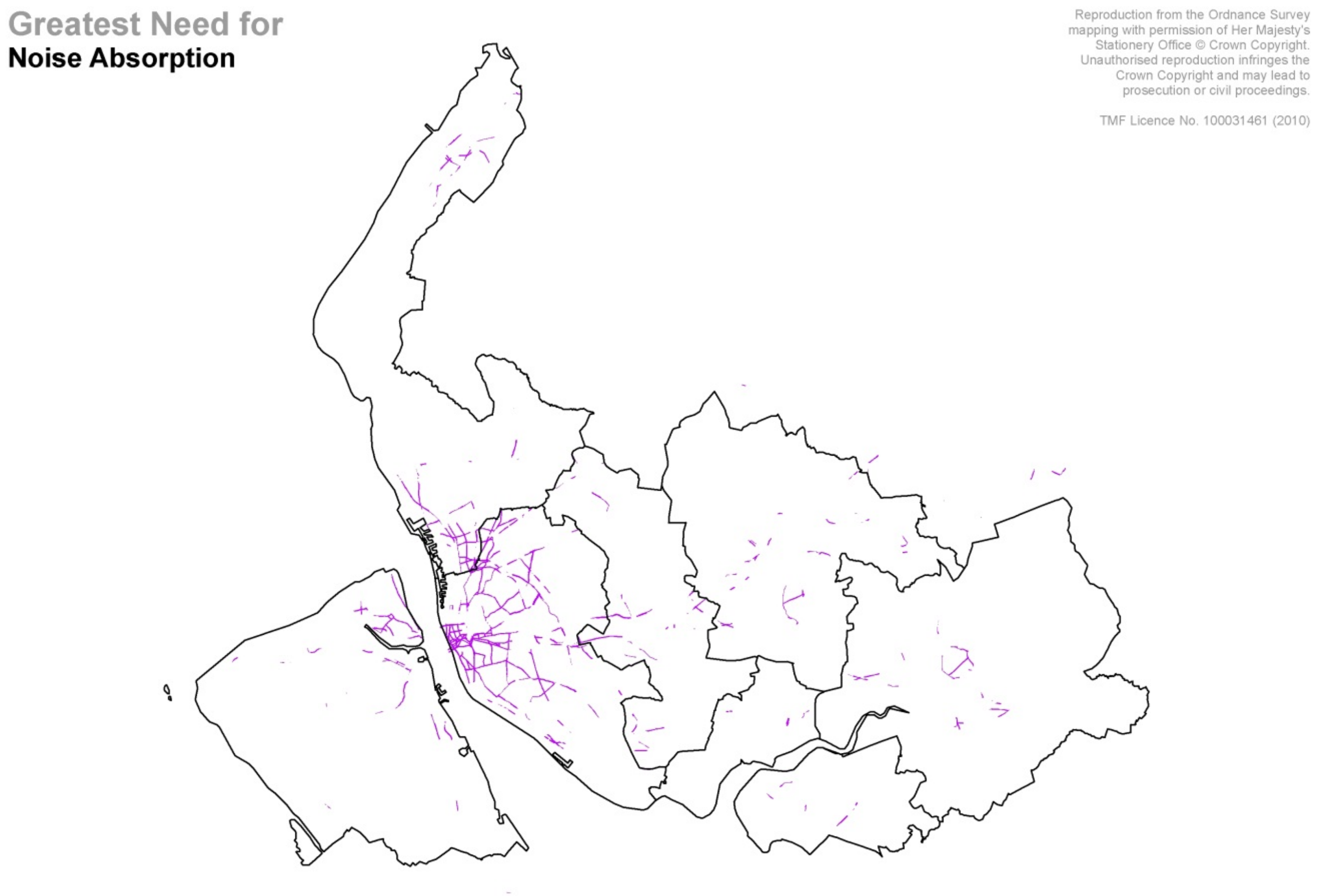


Figure 95 Pollutant removal from soil/water

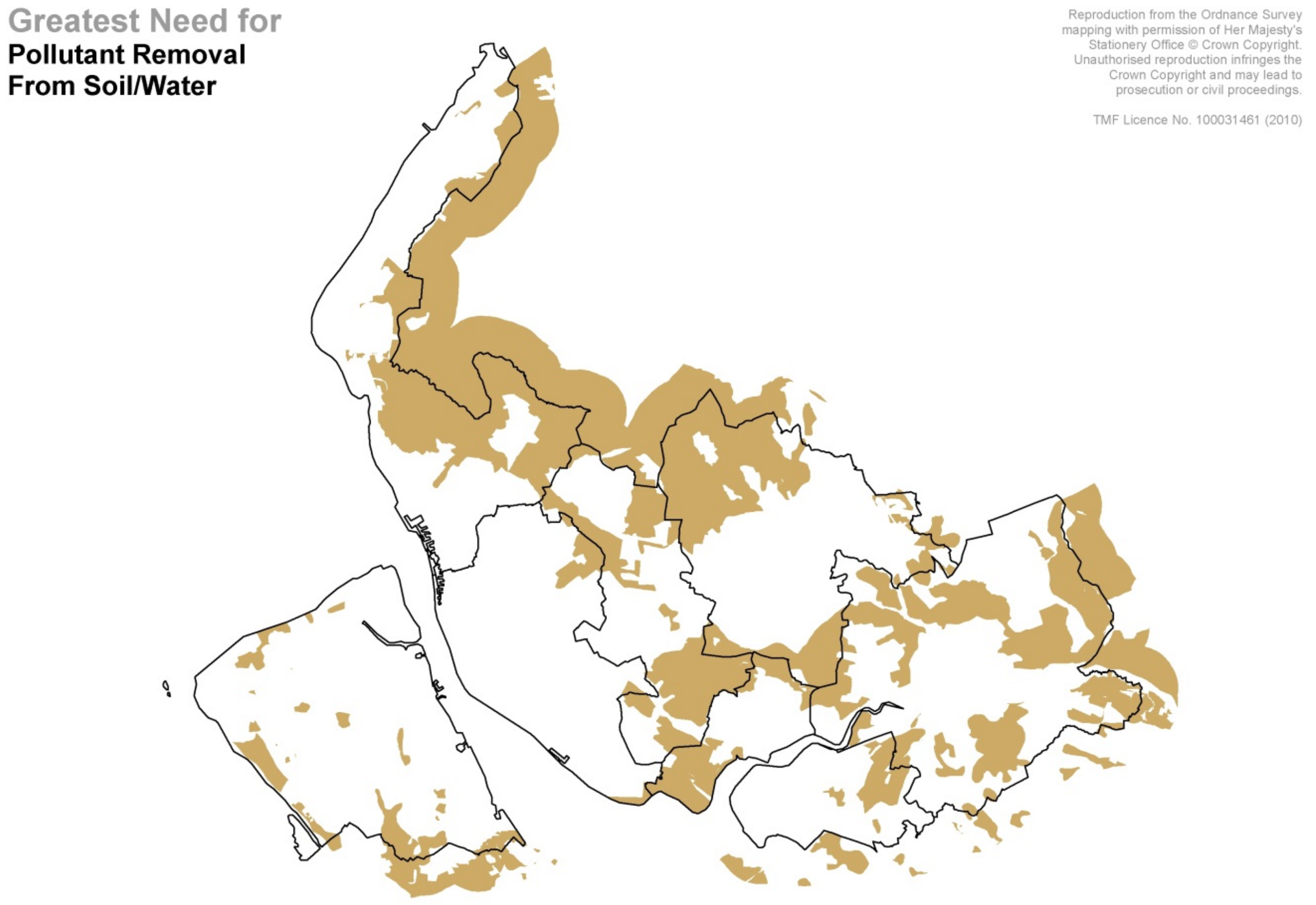


Figure 96 Recreation - private

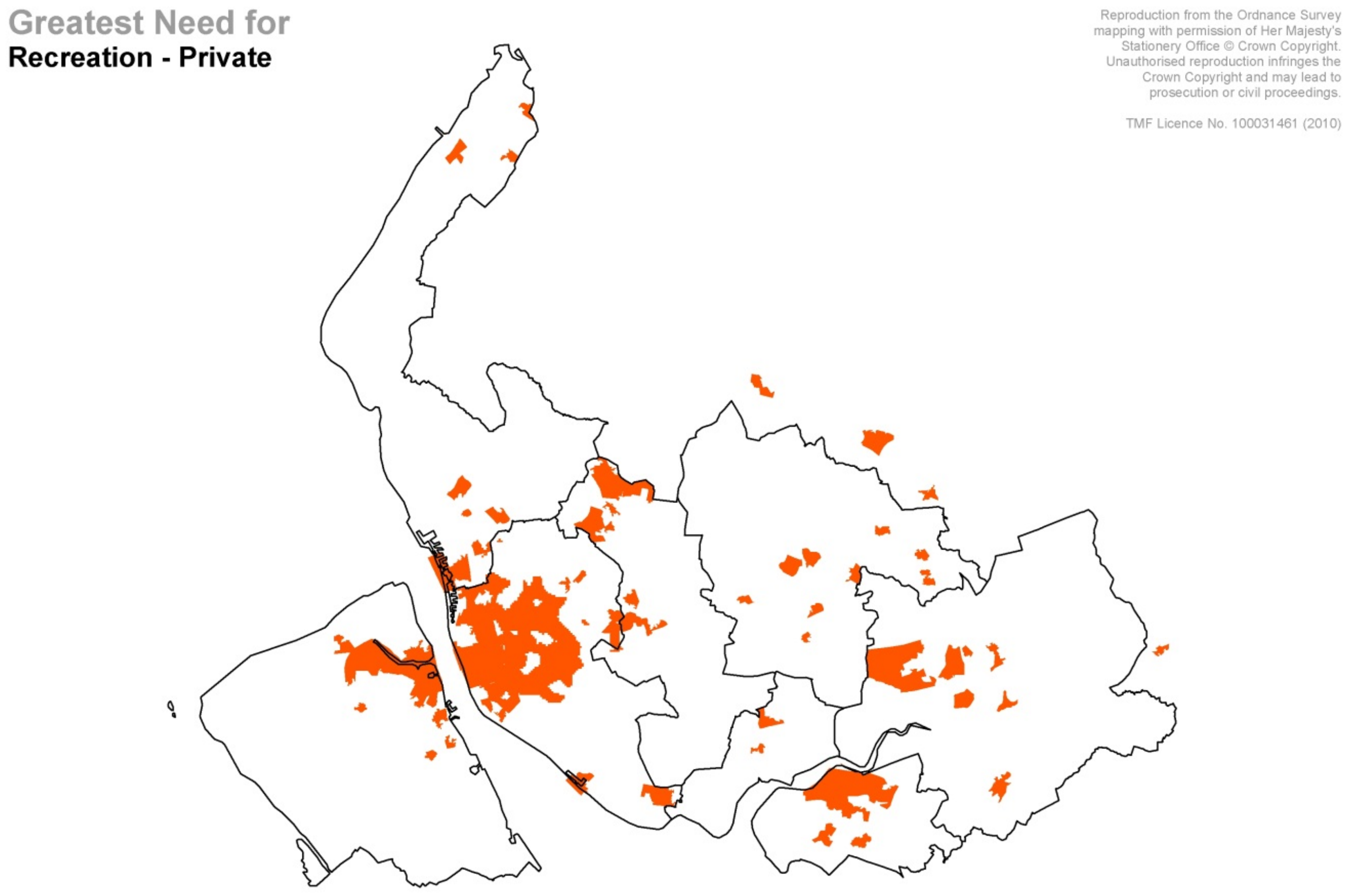


Figure 97 Recreation - public with restrictions

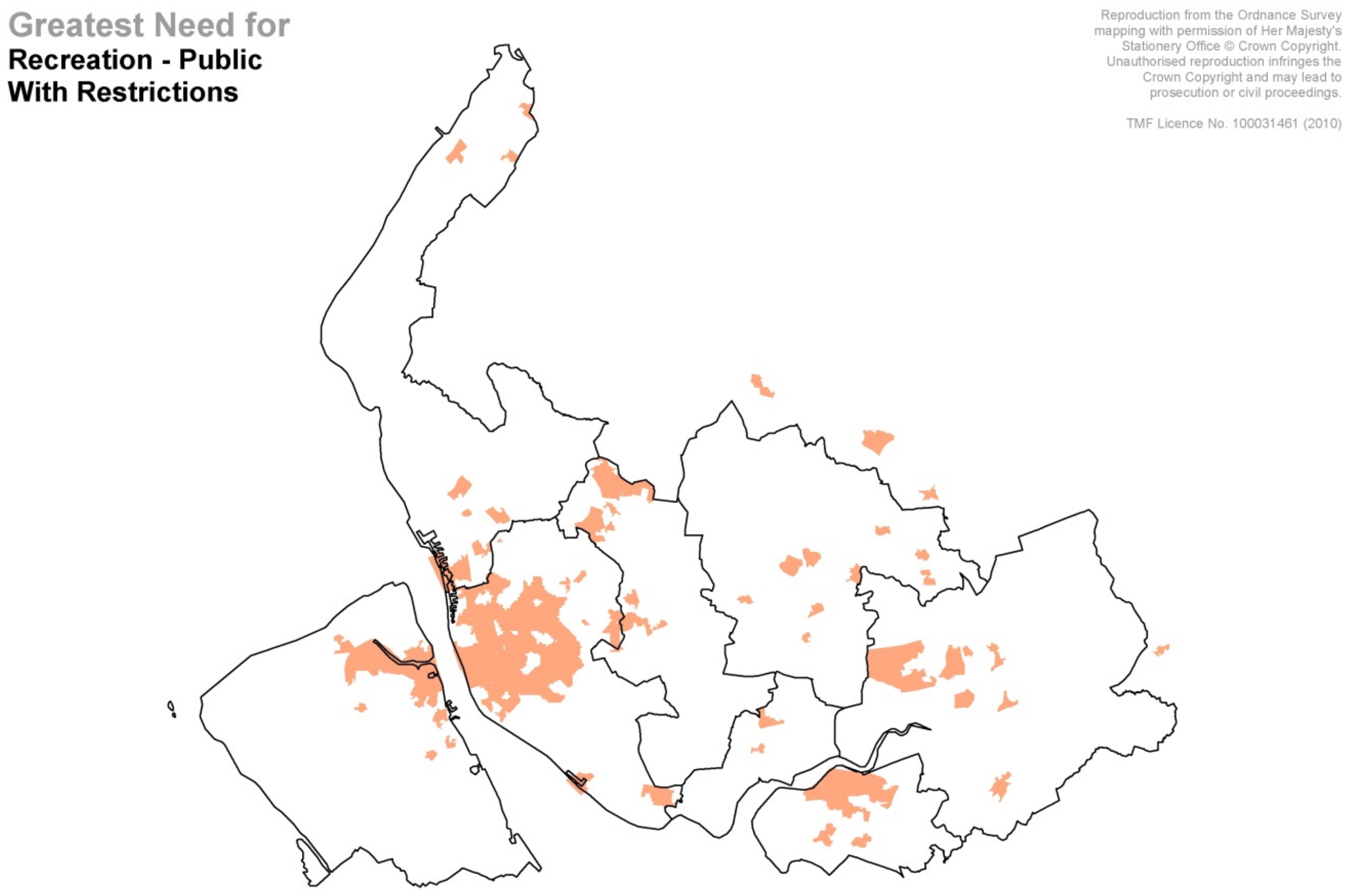


Figure 98 Recreation - public

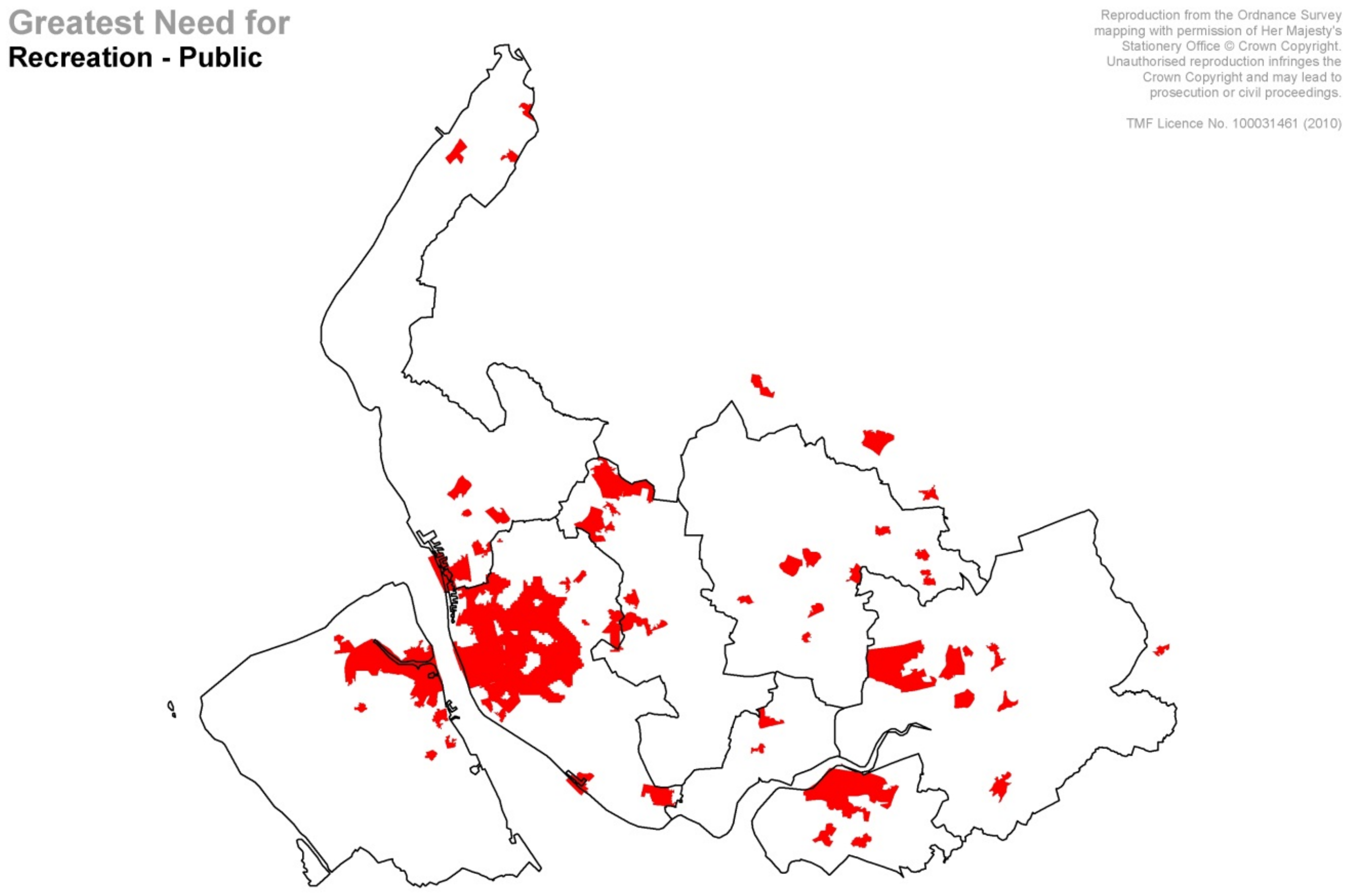


Figure 99 Shading from the sun

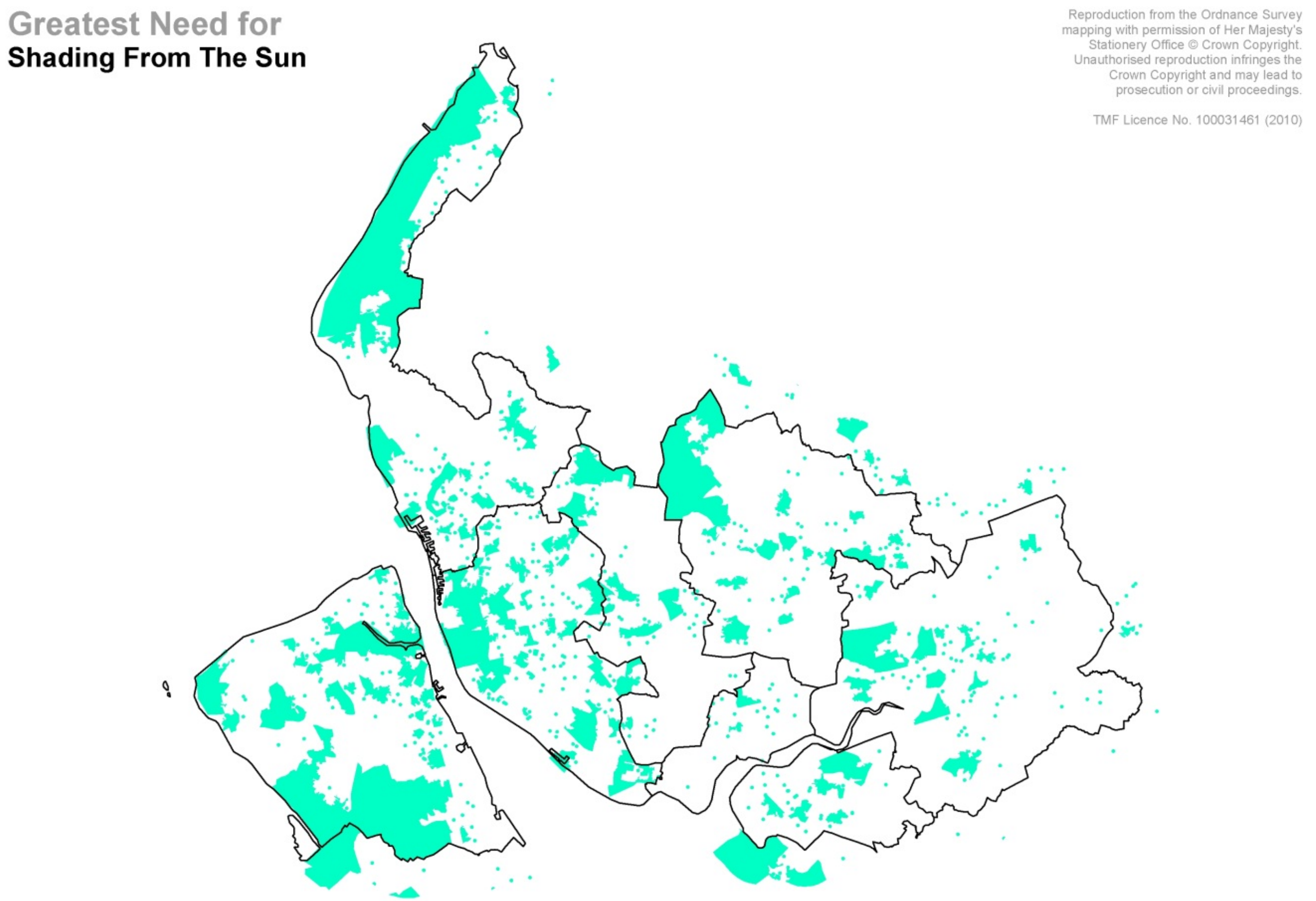


Figure 100 Soil stabilisation

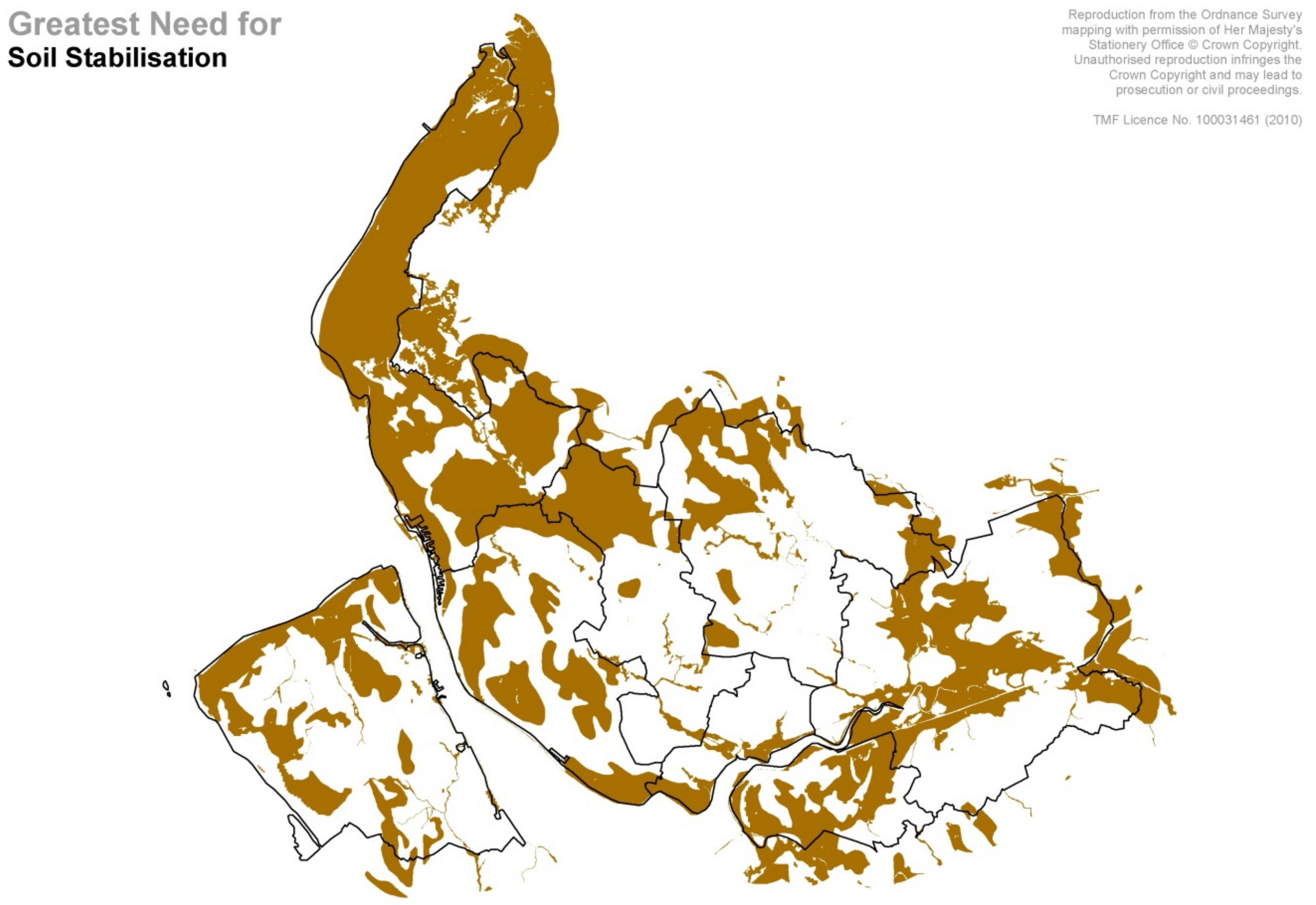


Figure 101 Timber production

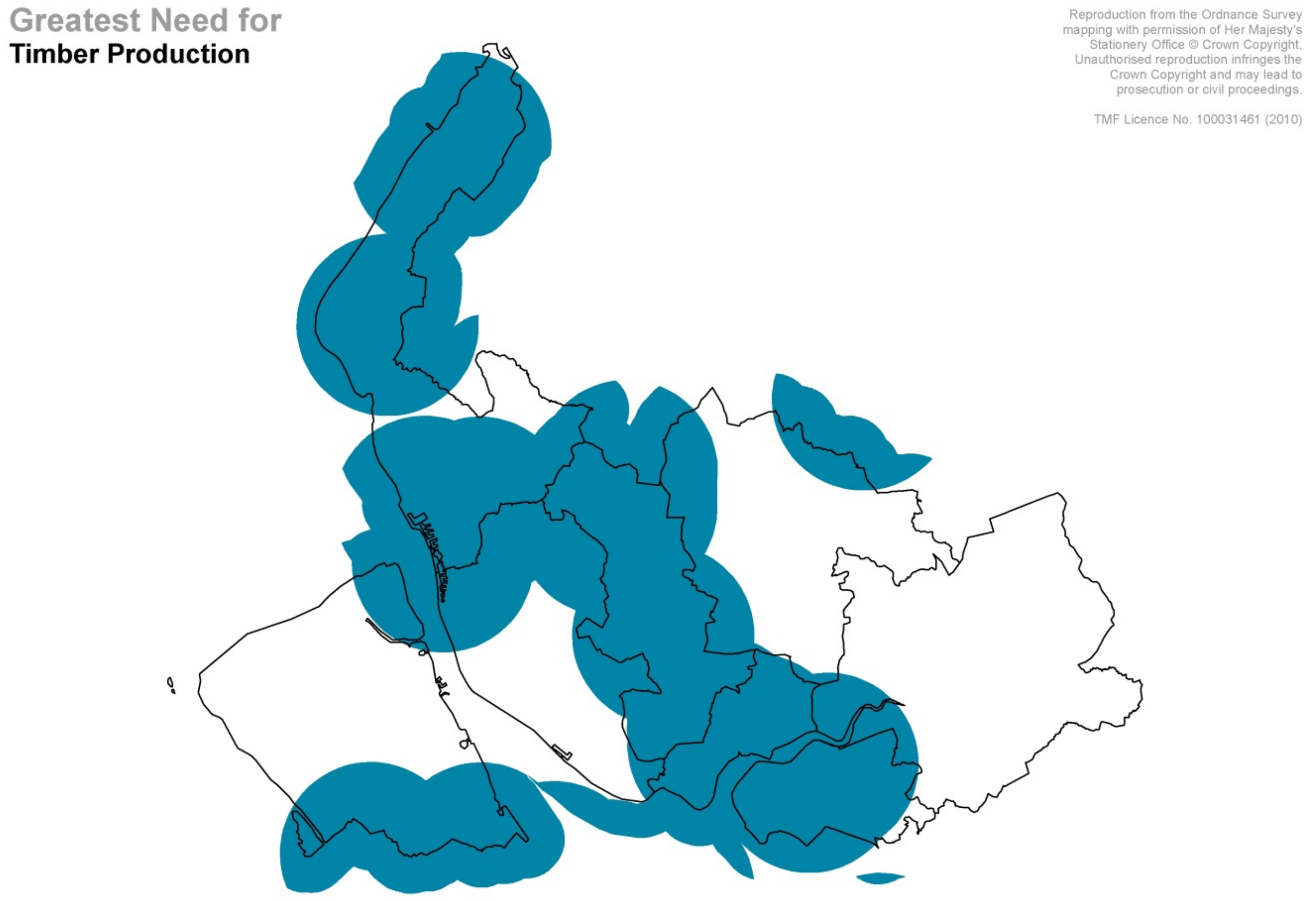


Figure 102 Trapping air pollutants

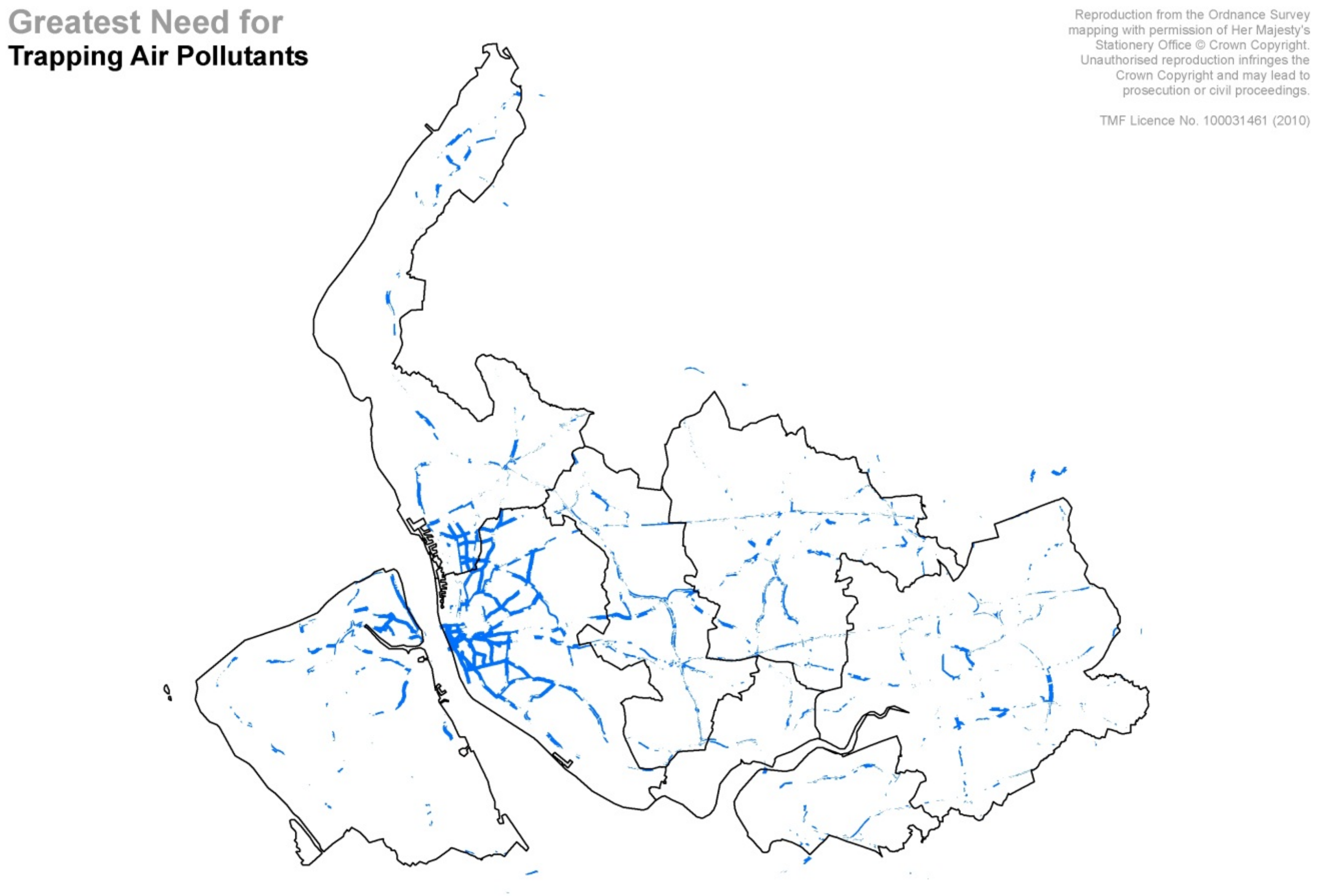


Figure 103 Water conveyance

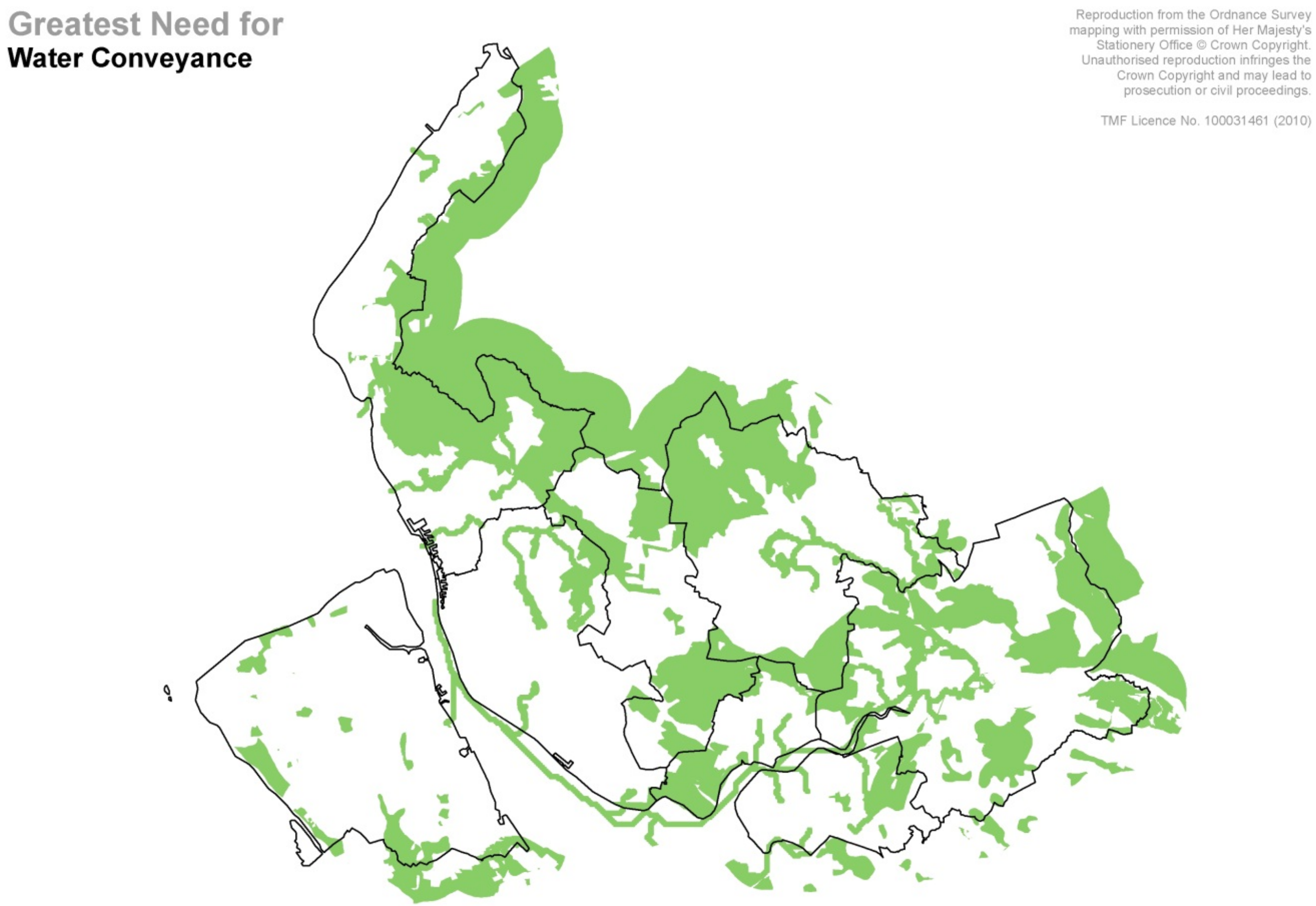


Figure 104 Water infiltration

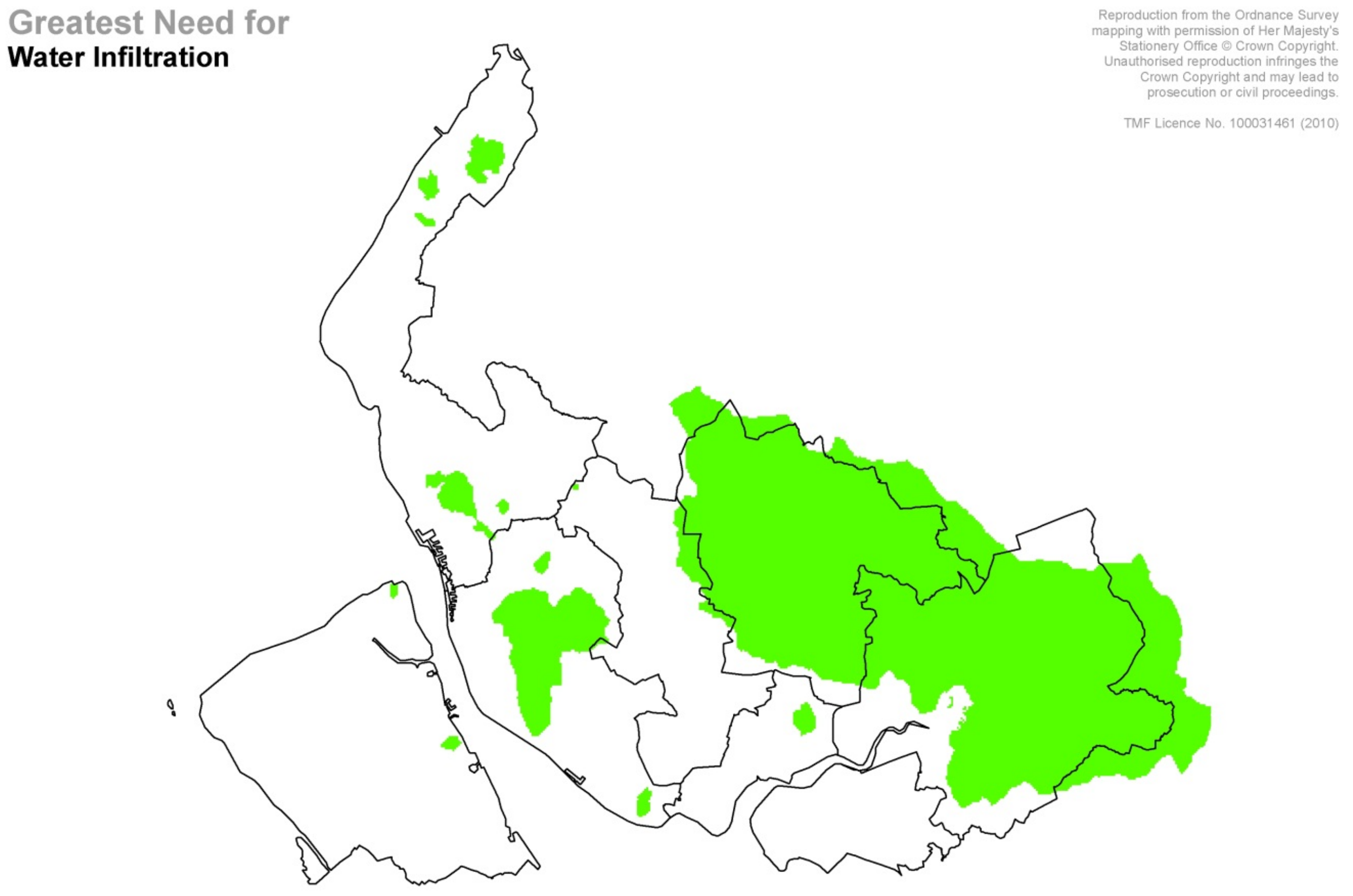
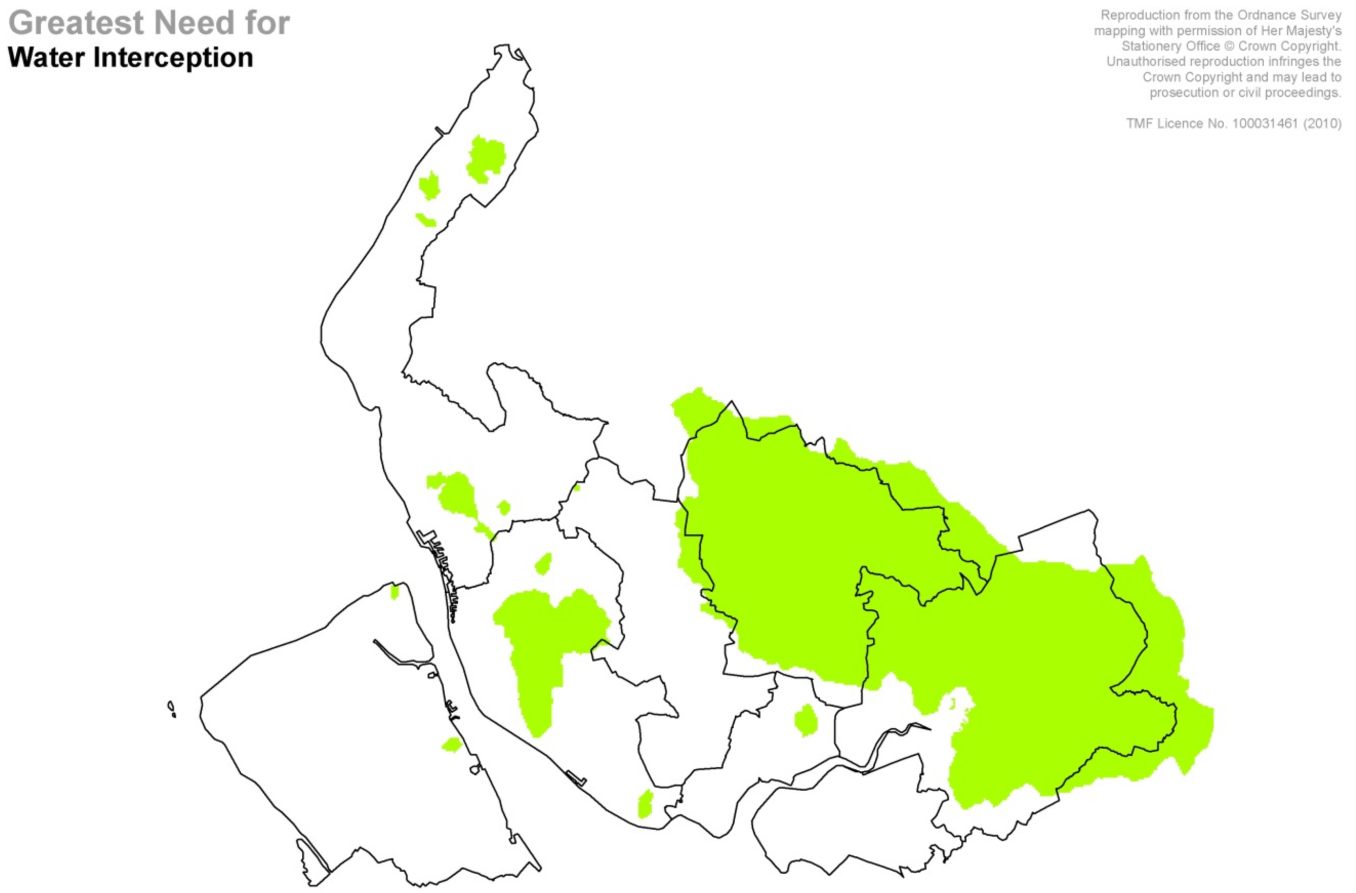


Figure 105 Water interception



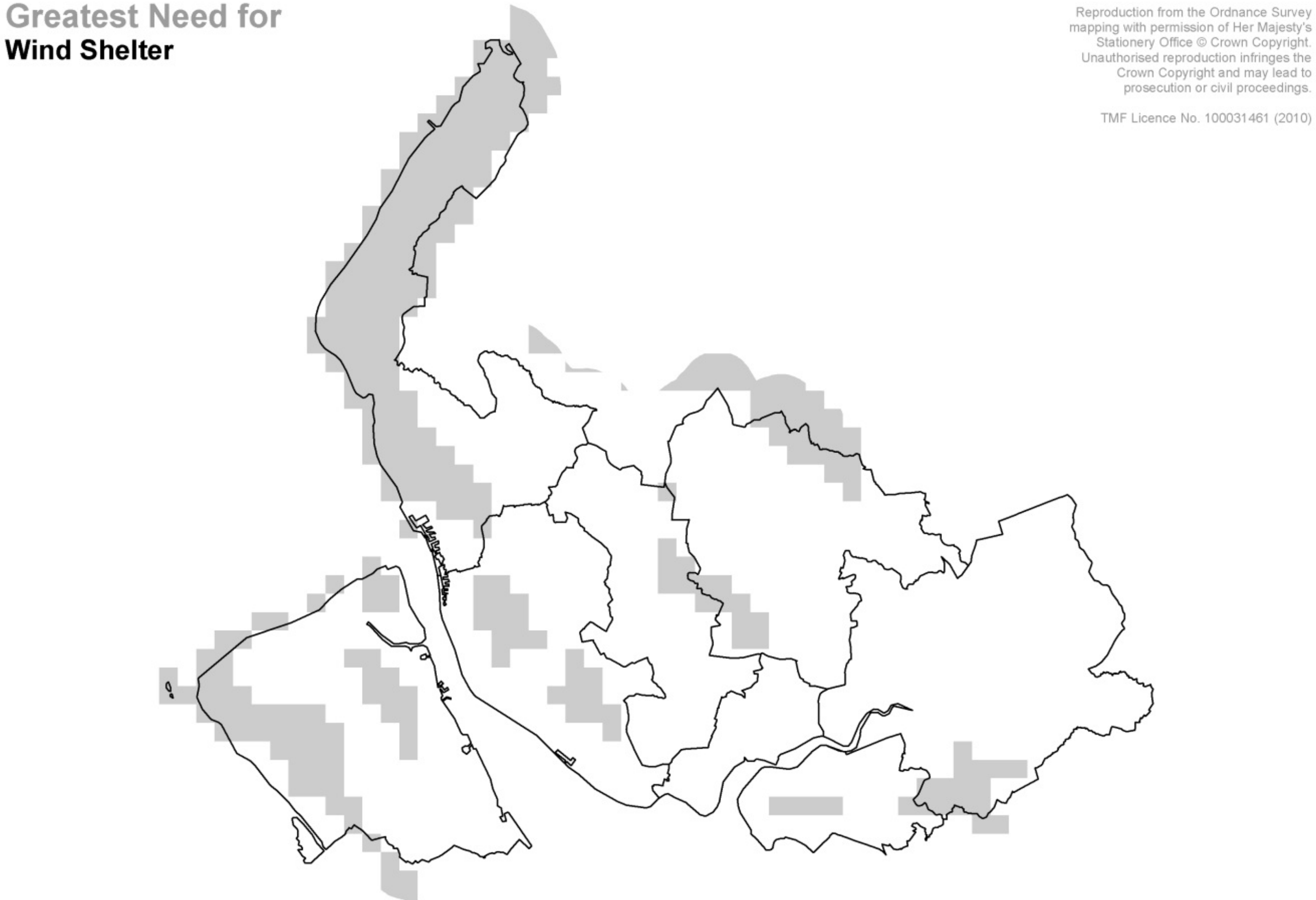


Figure 106 Wind shelter

17. Needs fulfilled and not fulfilled

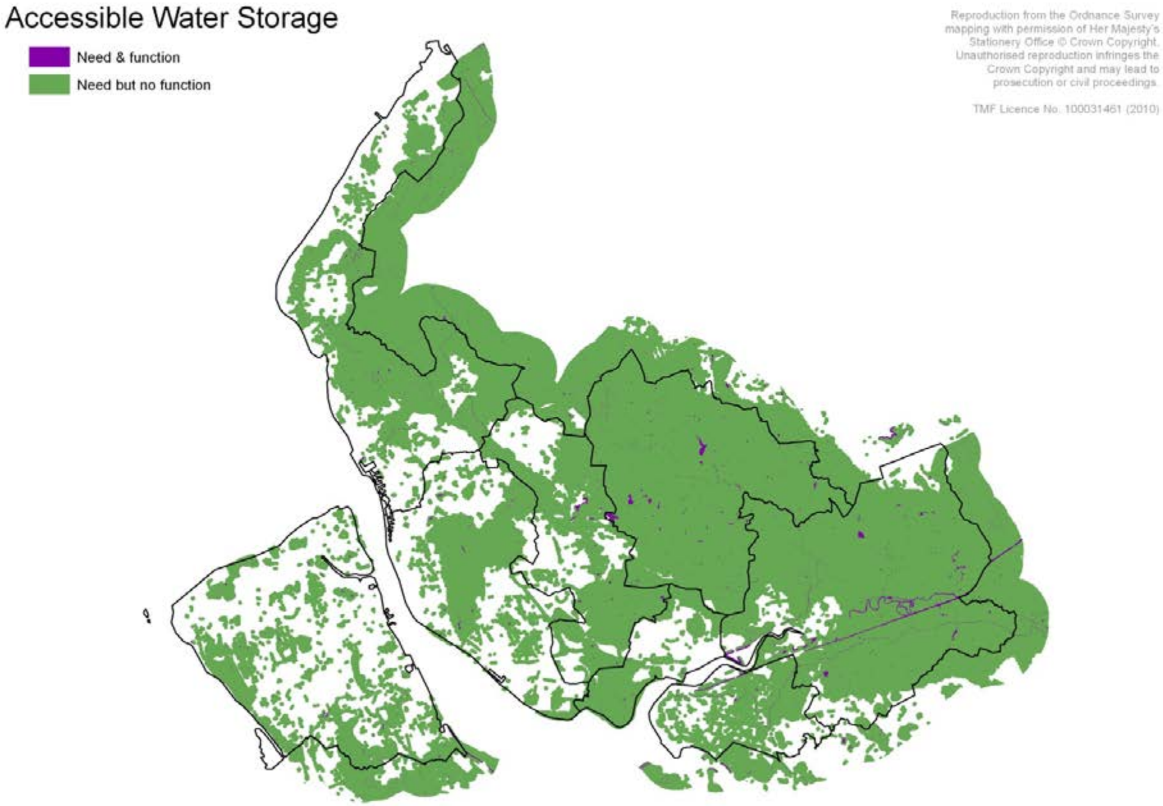


Figure 107 Accessible water storage

Figure 108 Aesthetic

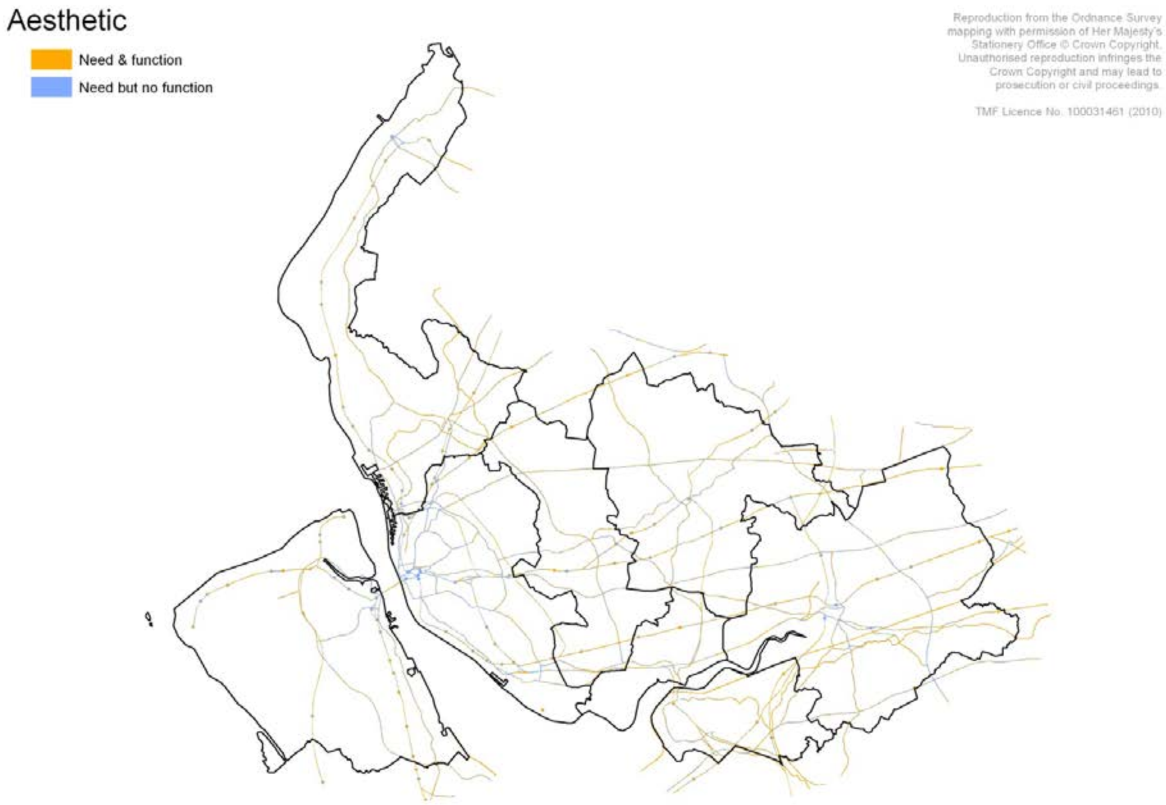


Figure 109 Biofuels production

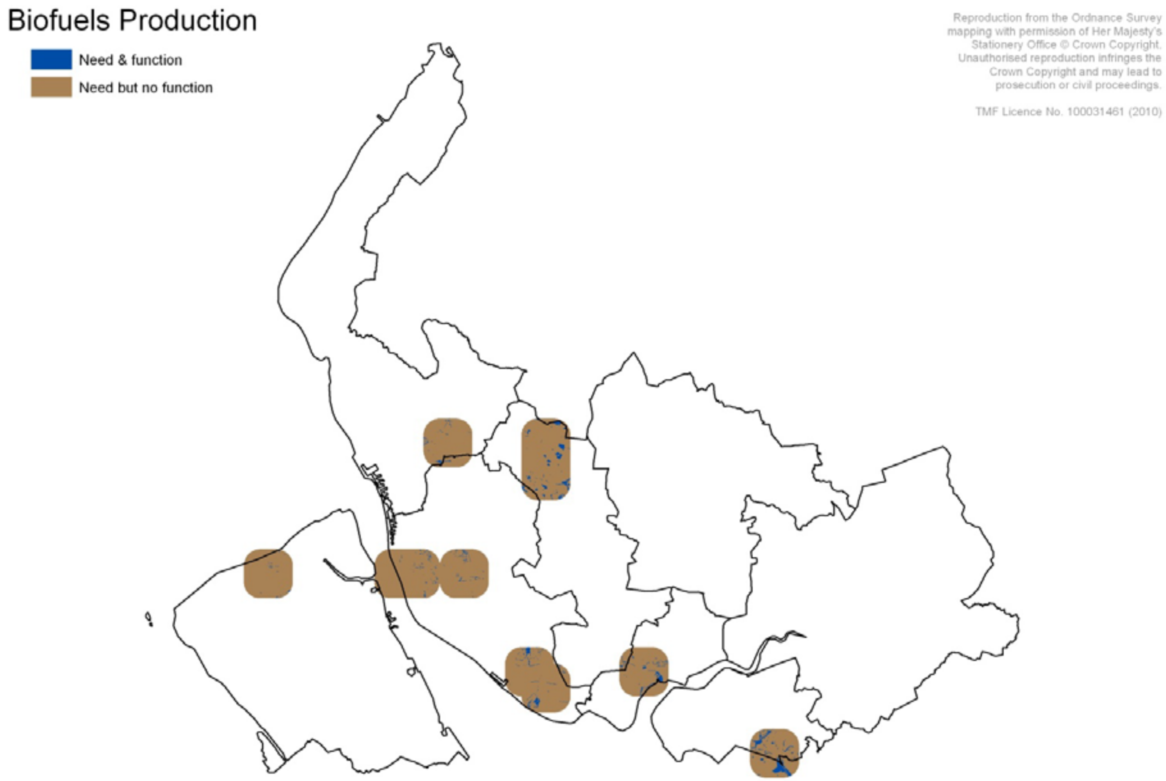


Figure 110 Carbon storage

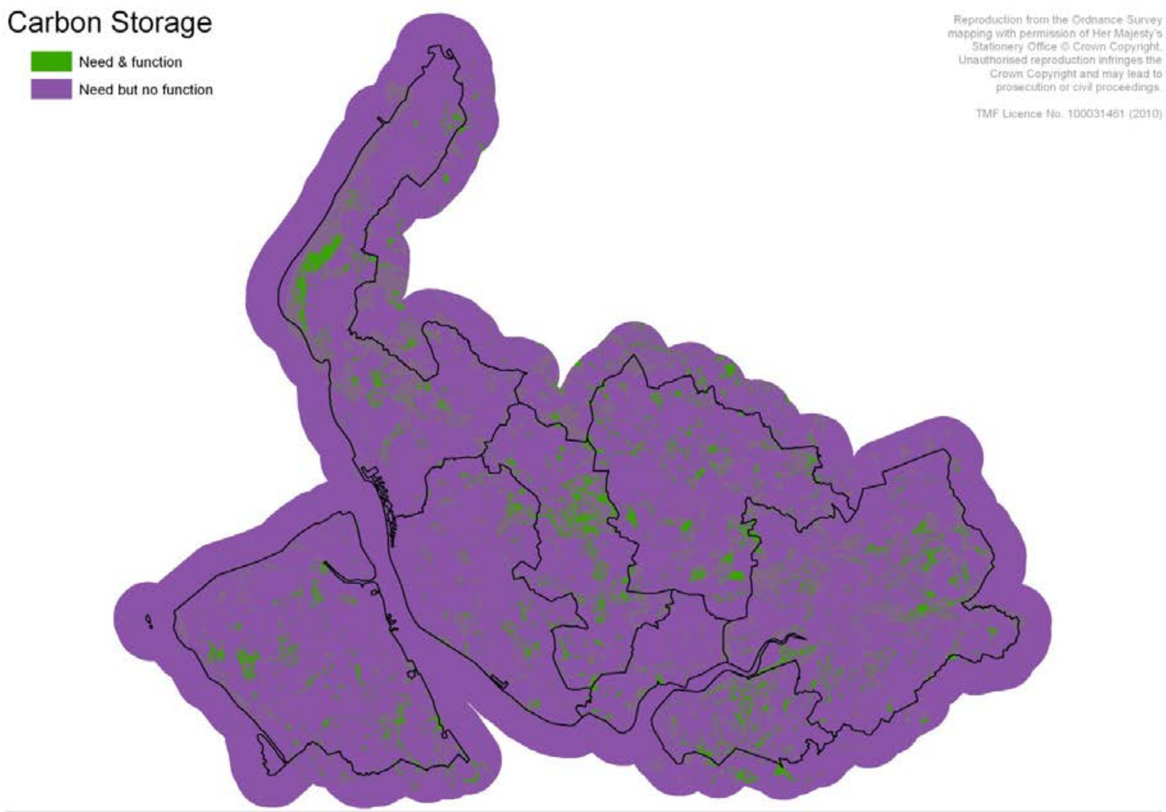


Figure 111 Coastal storm protection

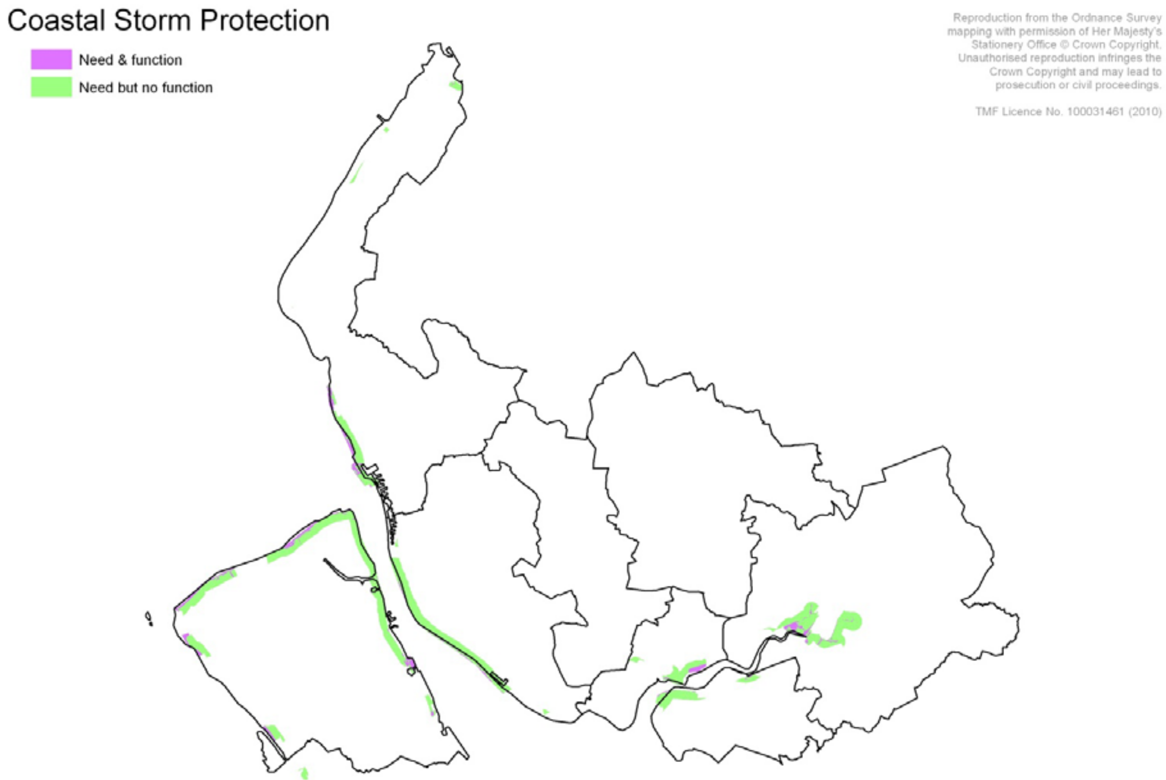


Figure 112 Corridor for wildlife

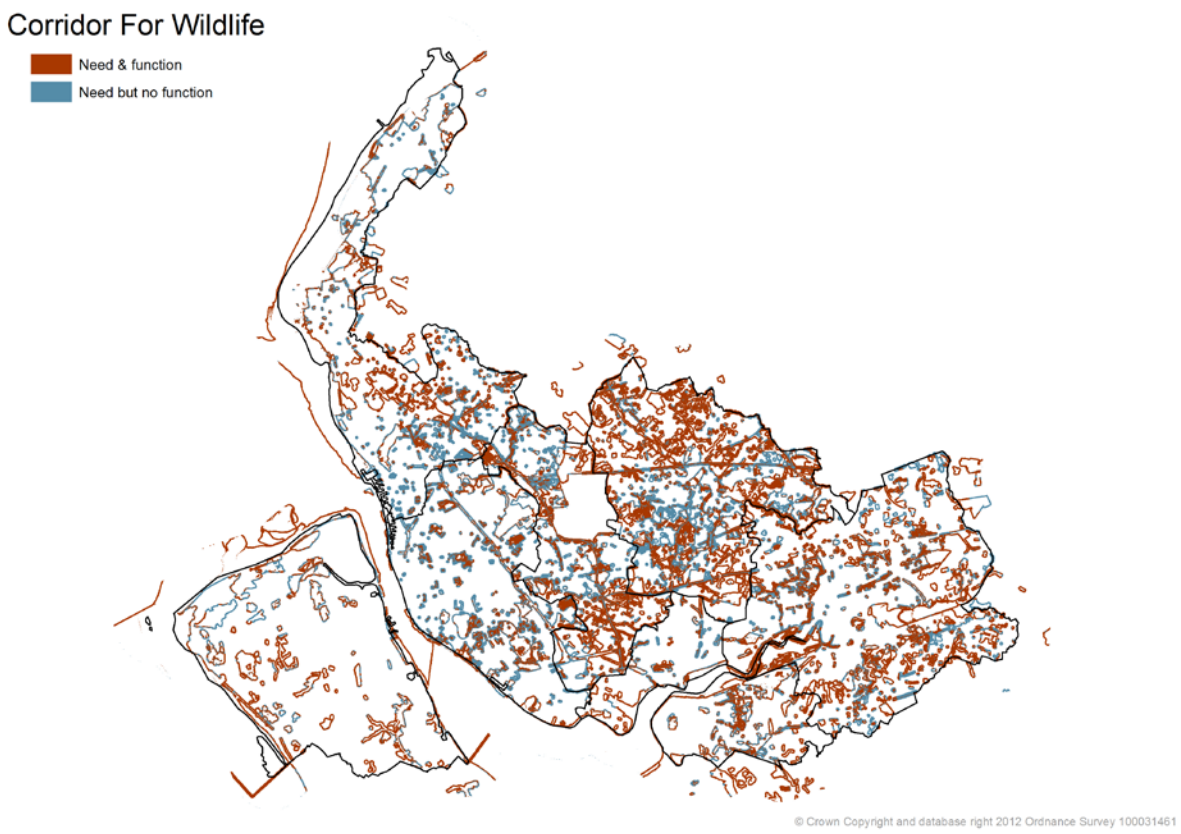


Figure 113 Cultural asset

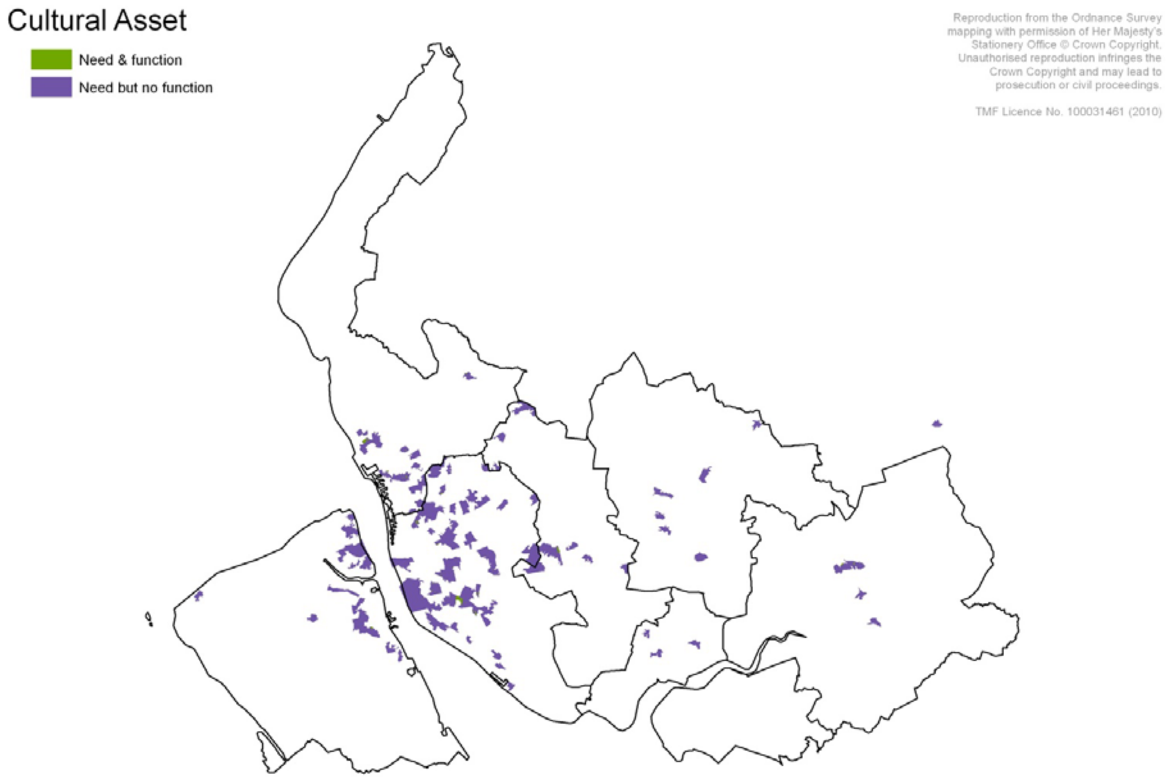


Figure 114 Evaporative cooling

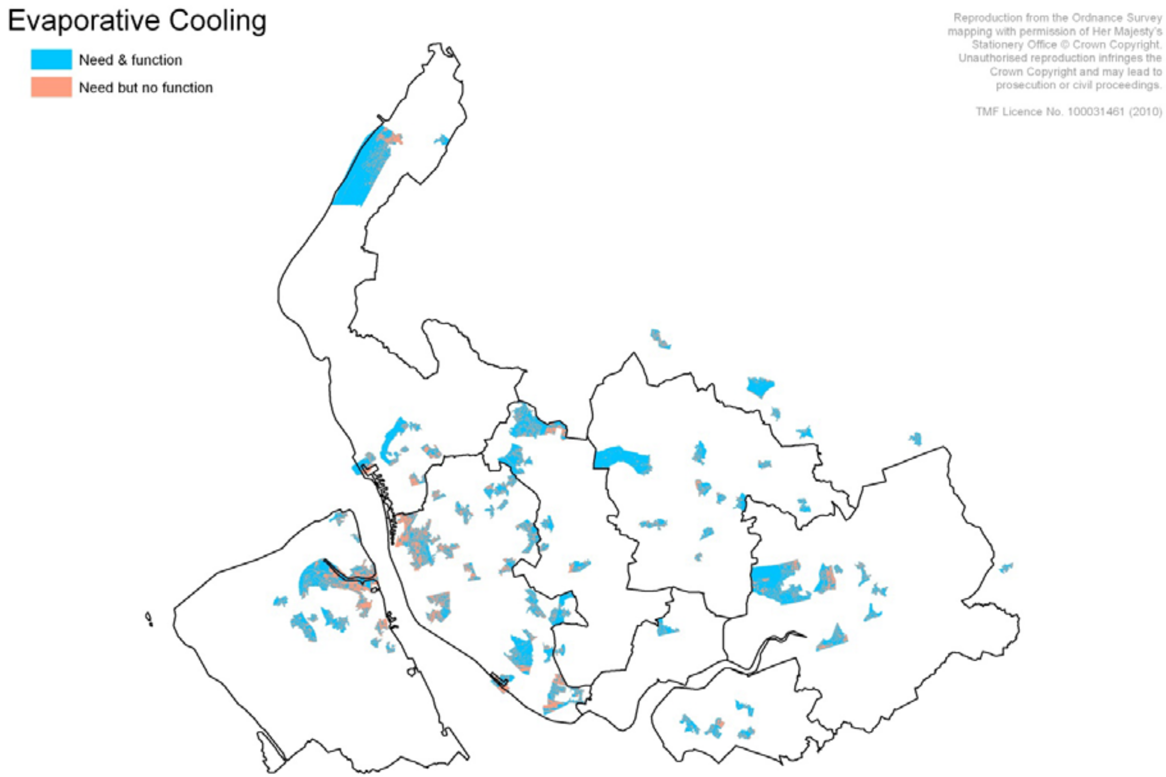


Figure 115 Flow reduction through surface roughness

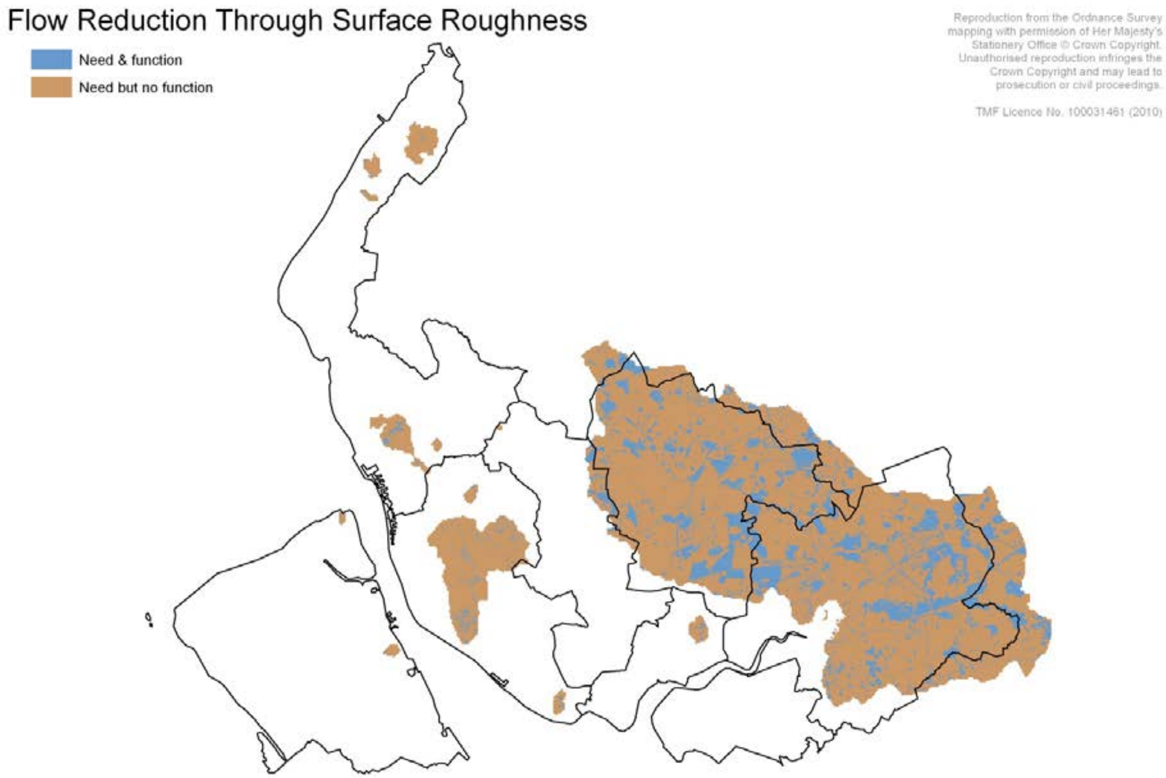


Figure 116 Food production

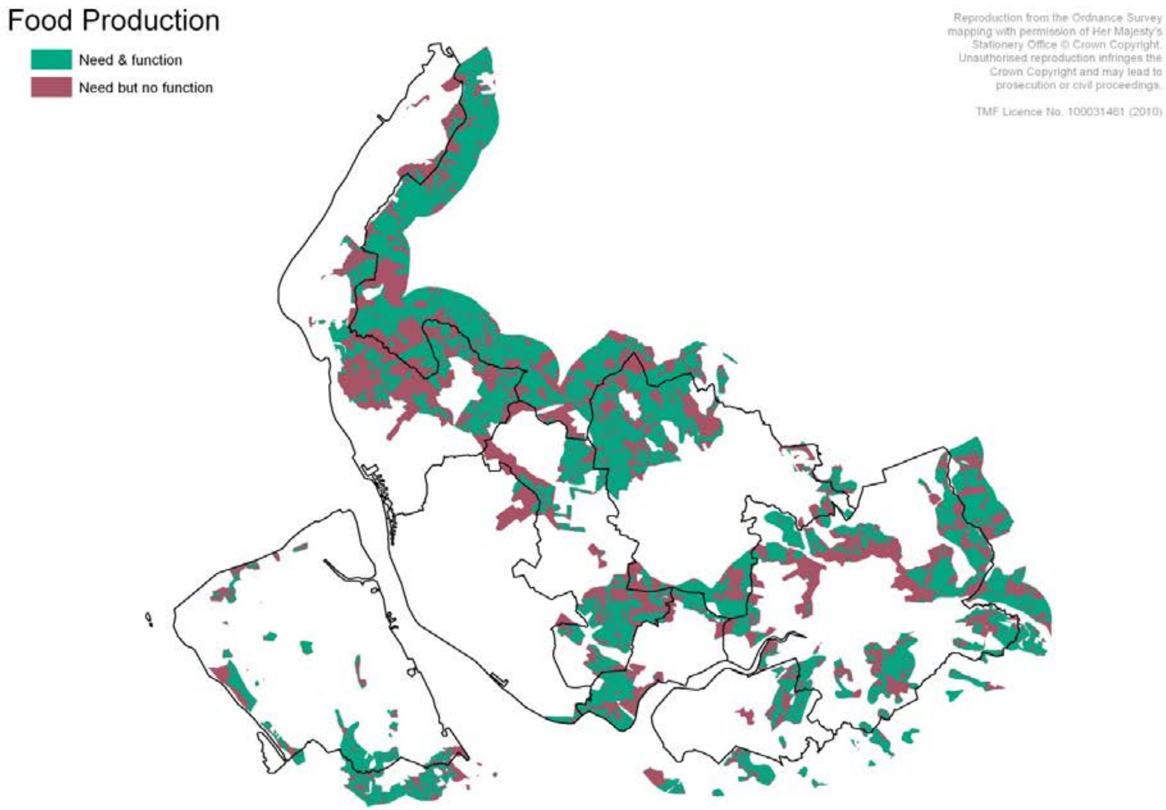


Figure 117 Green travel route

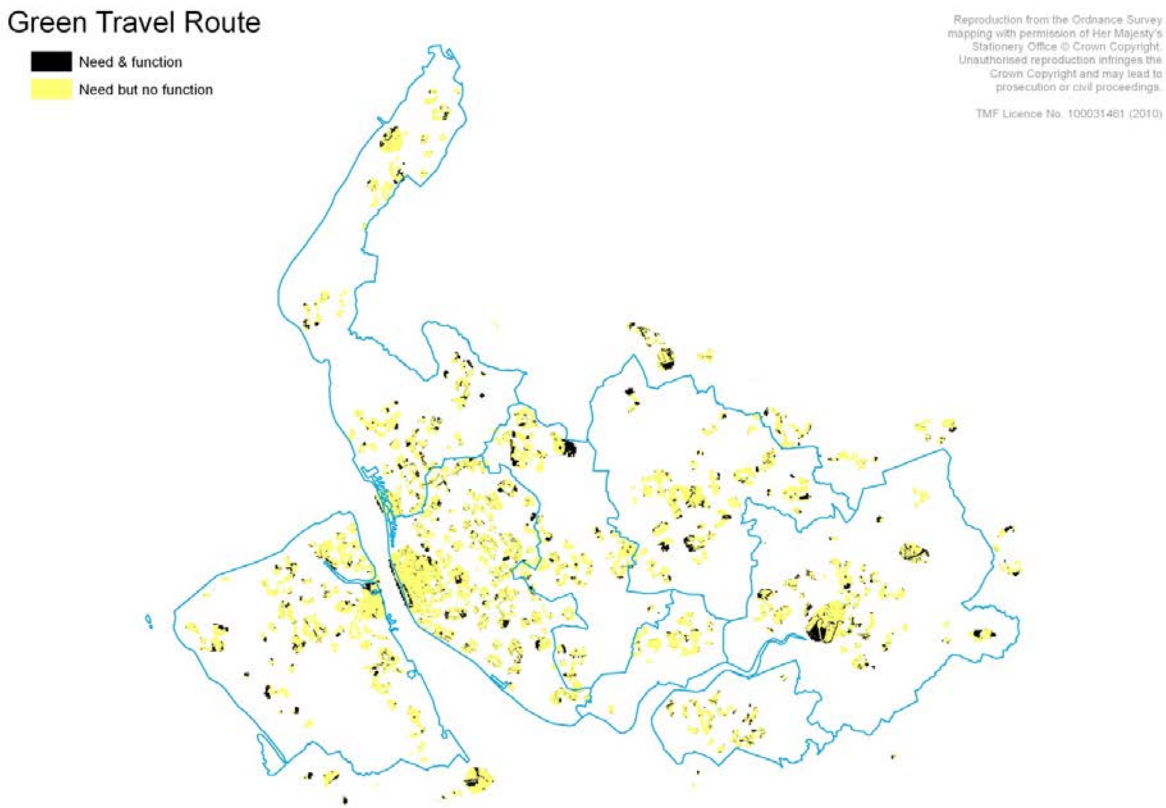


Figure 118 Habitat for wildlife

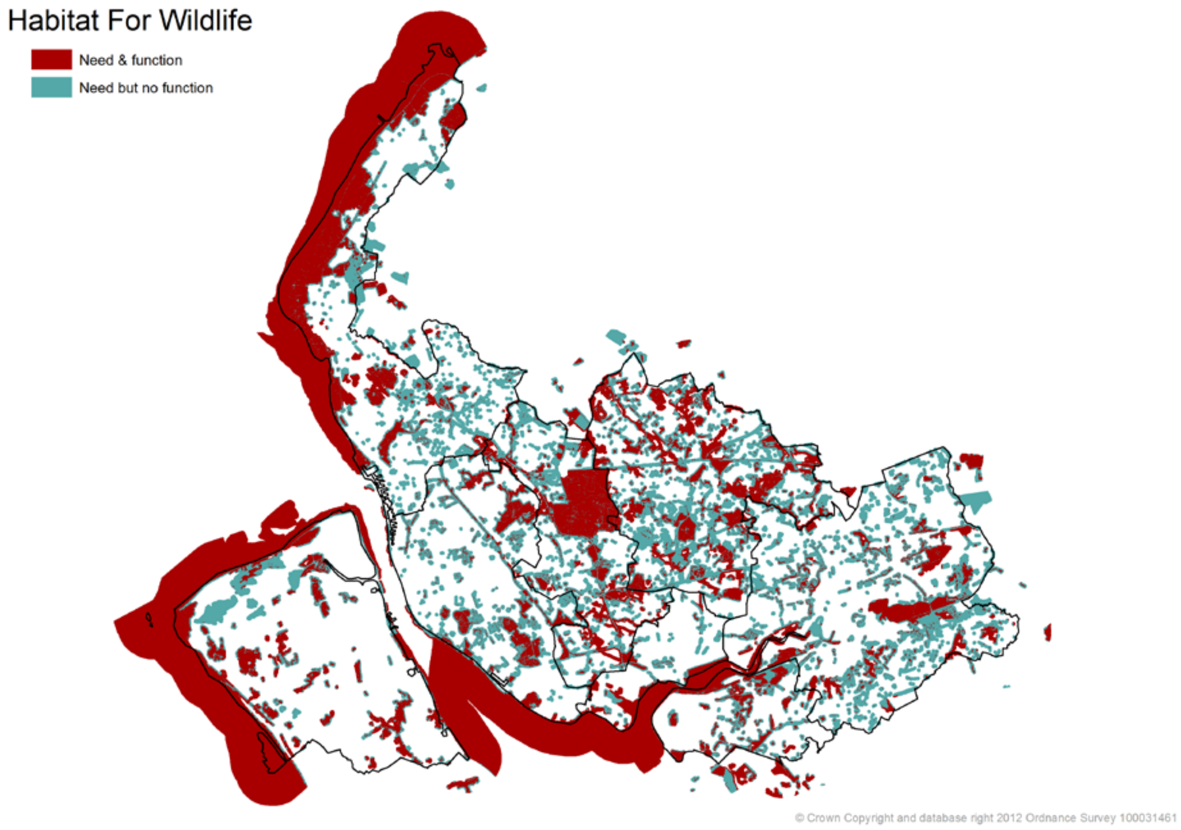


Figure 119 Heritage

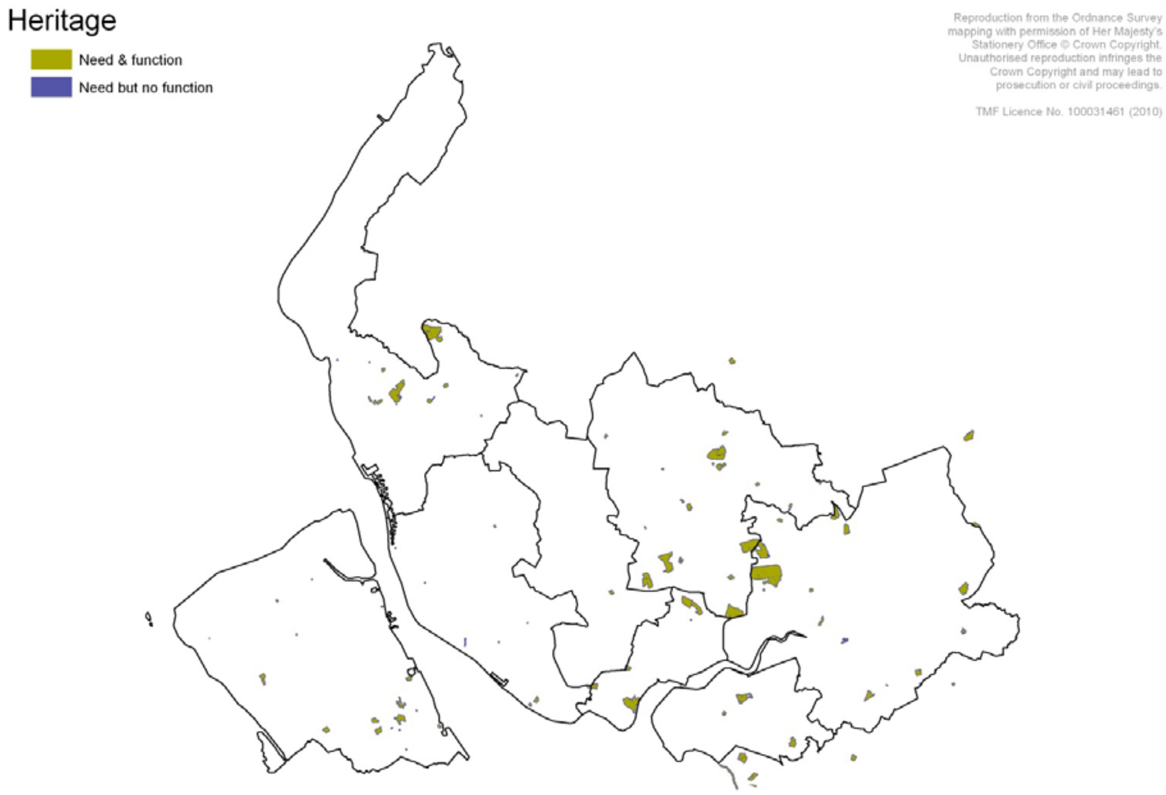


Figure 120 Inaccessible water storage

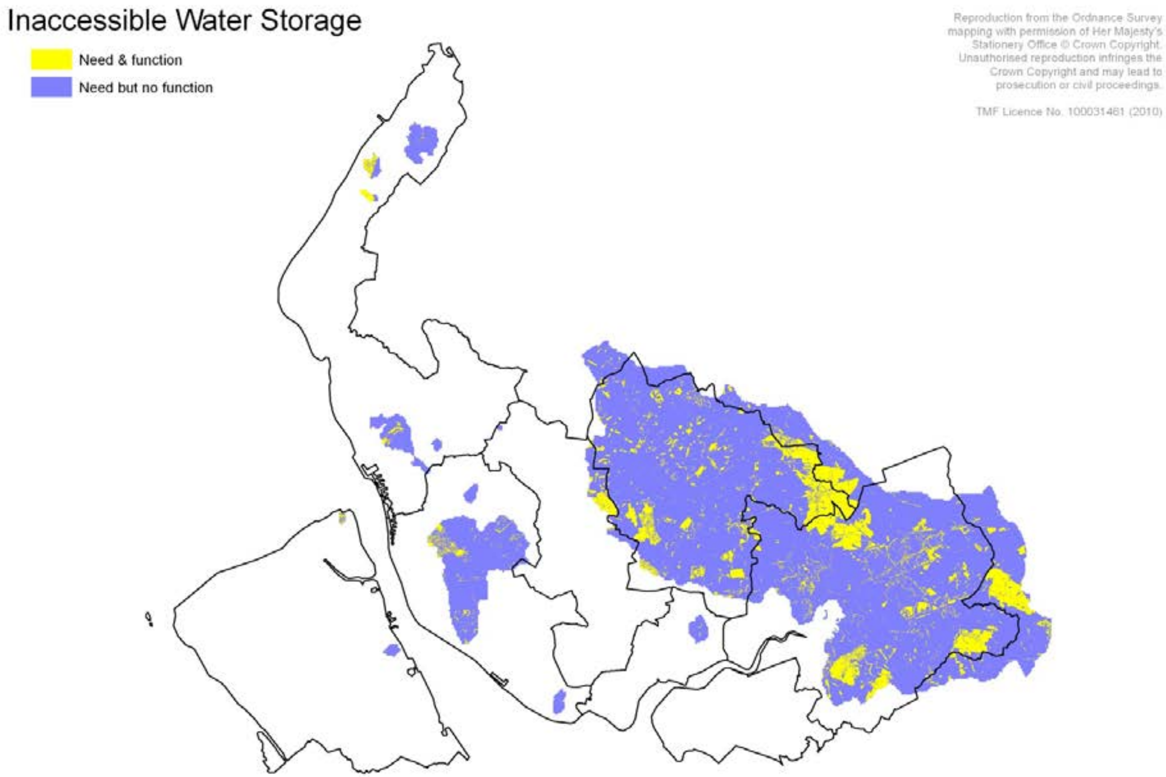


Figure 121 Learning

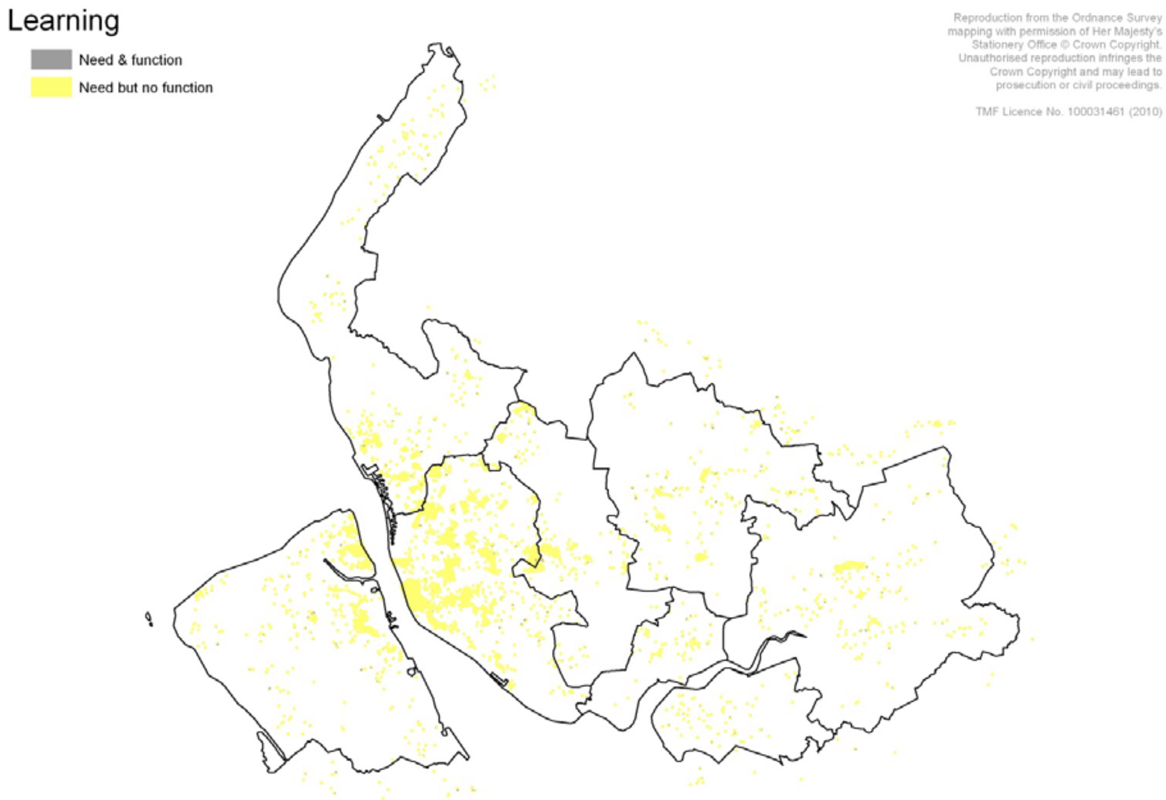
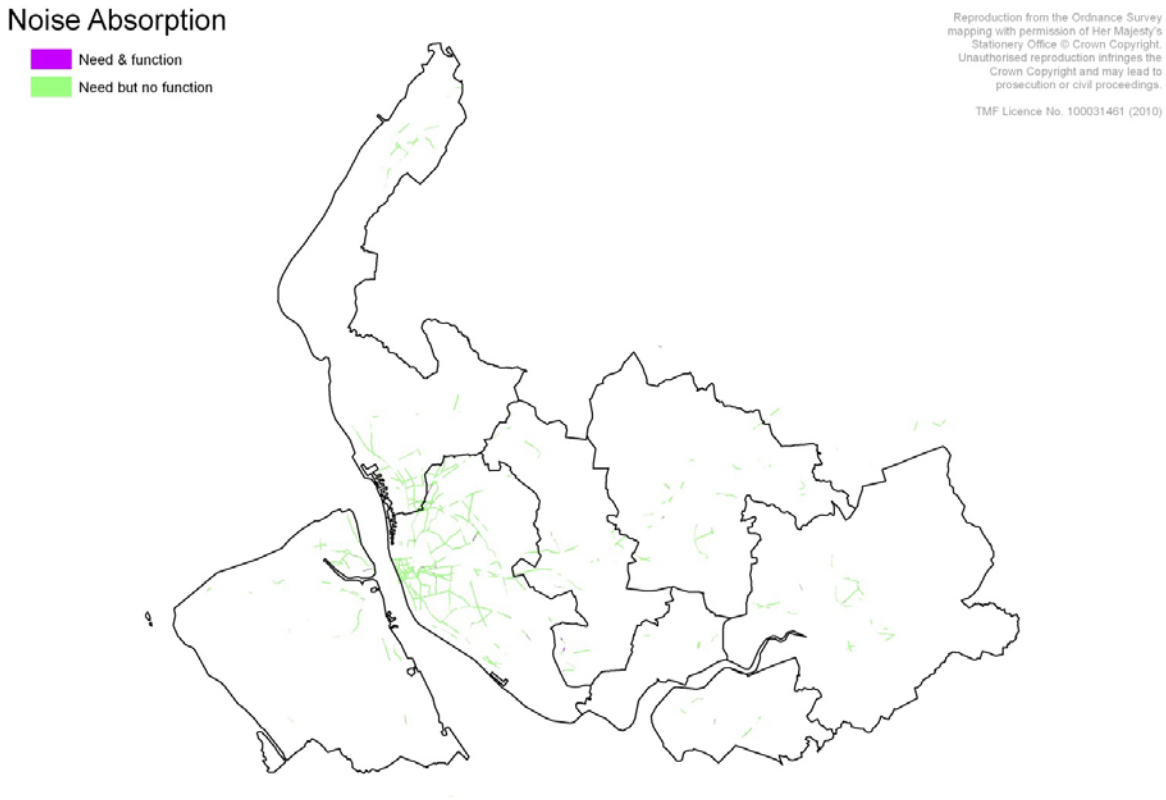


Figure 122 Noise absorption



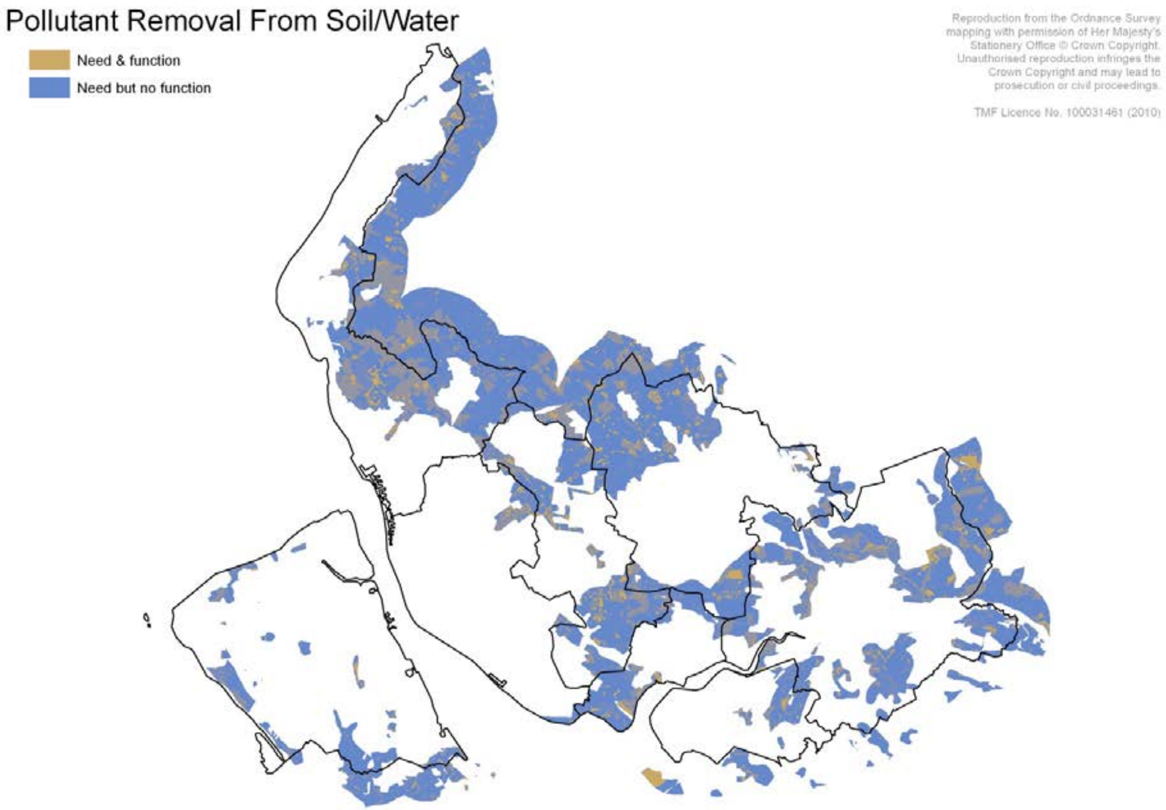


Figure 123 Pollutant removal from soil/water

Figure 124 Recreation - private

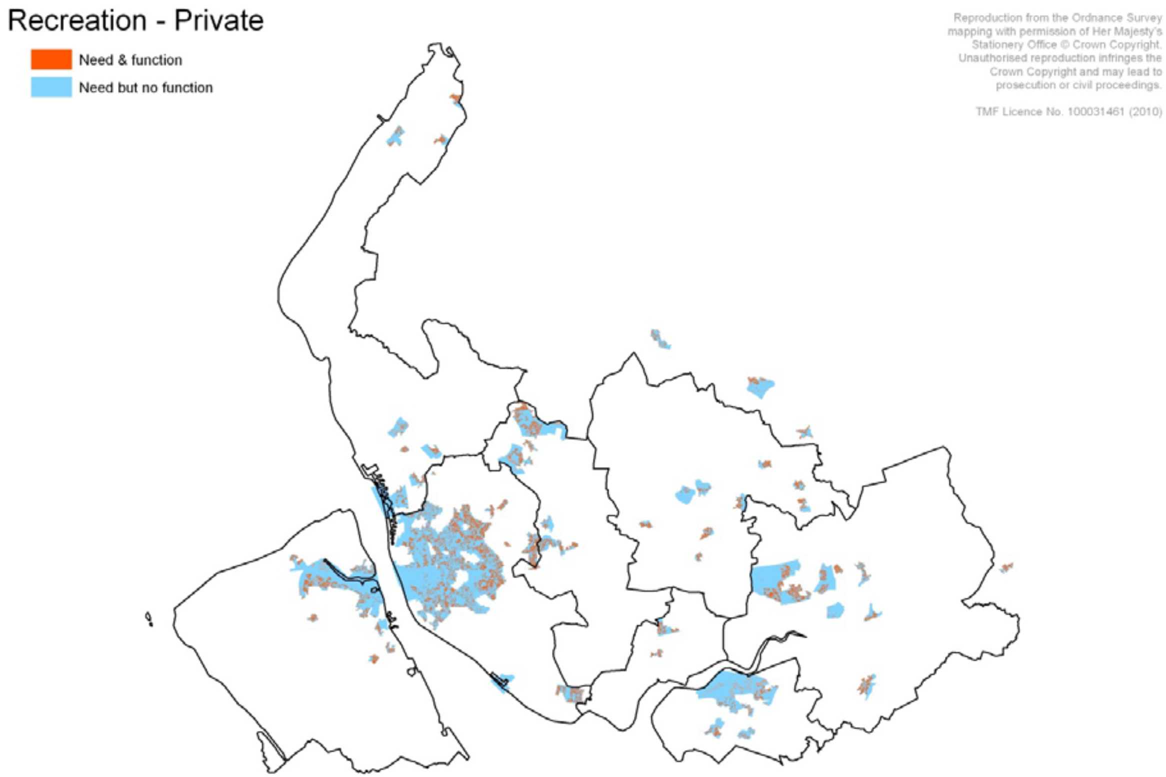


Figure 125 Recreation - public with restrictions

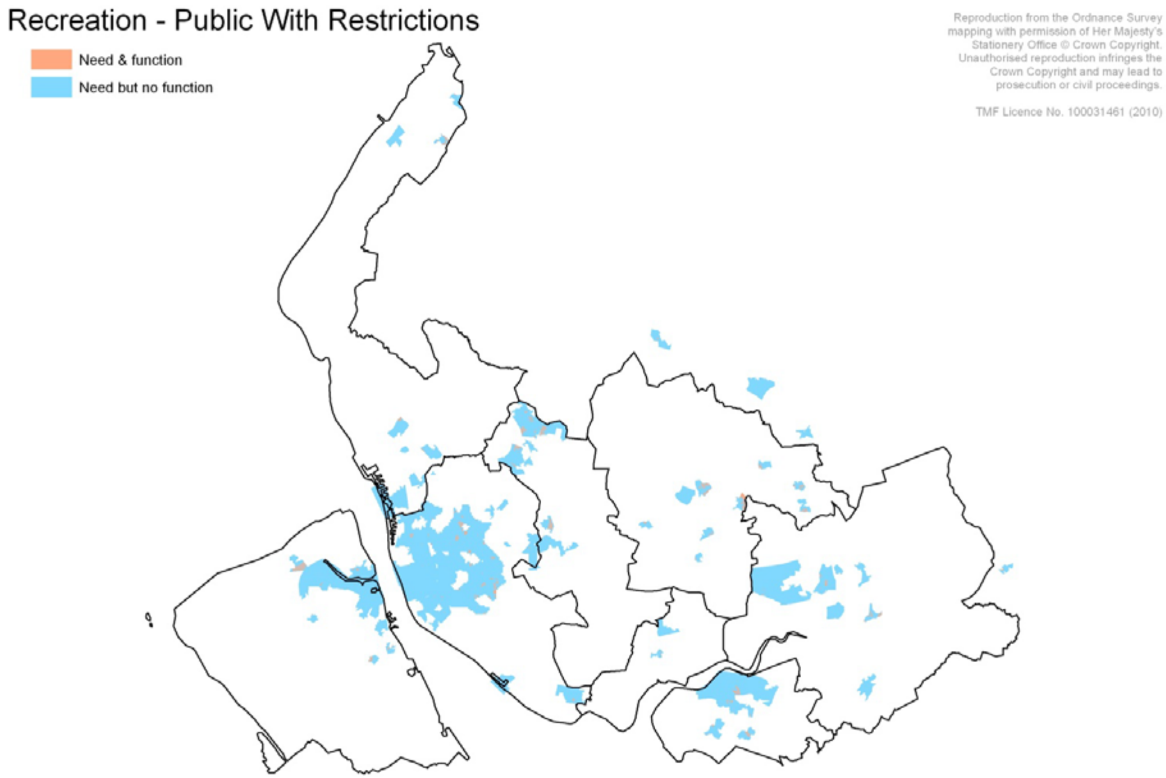


Figure 126 Recreation - public

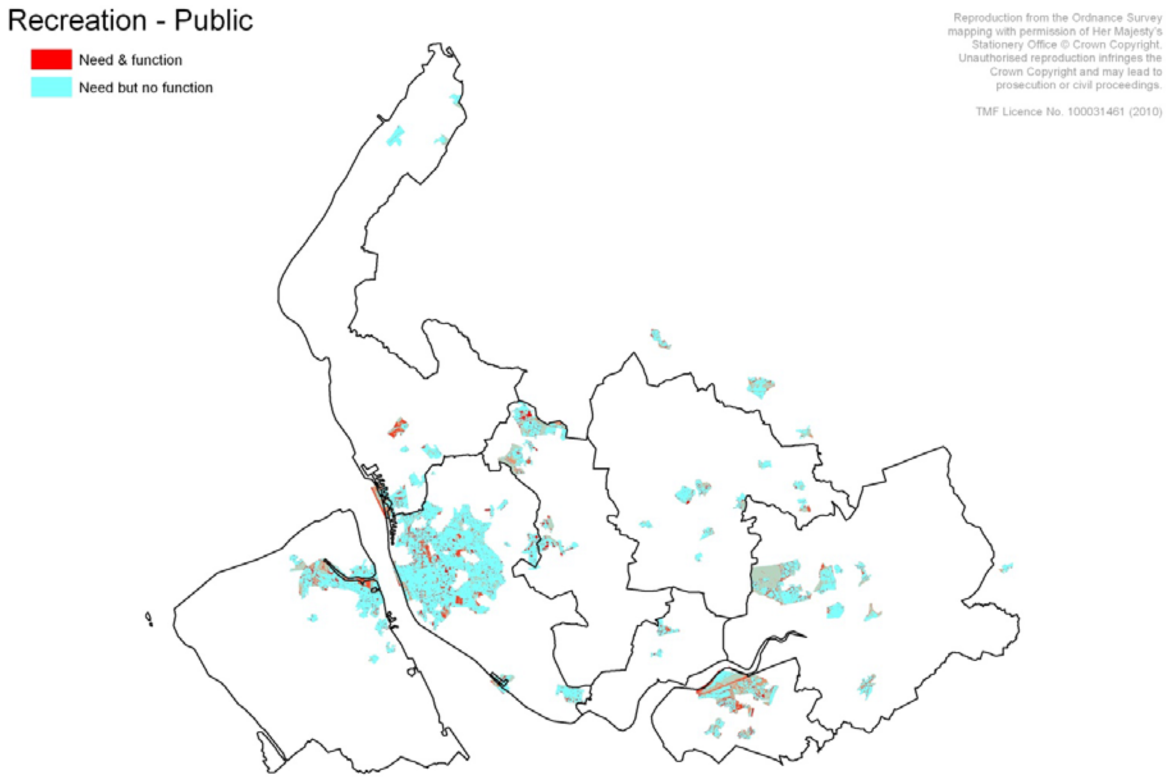


Figure 127 Shading from the sun

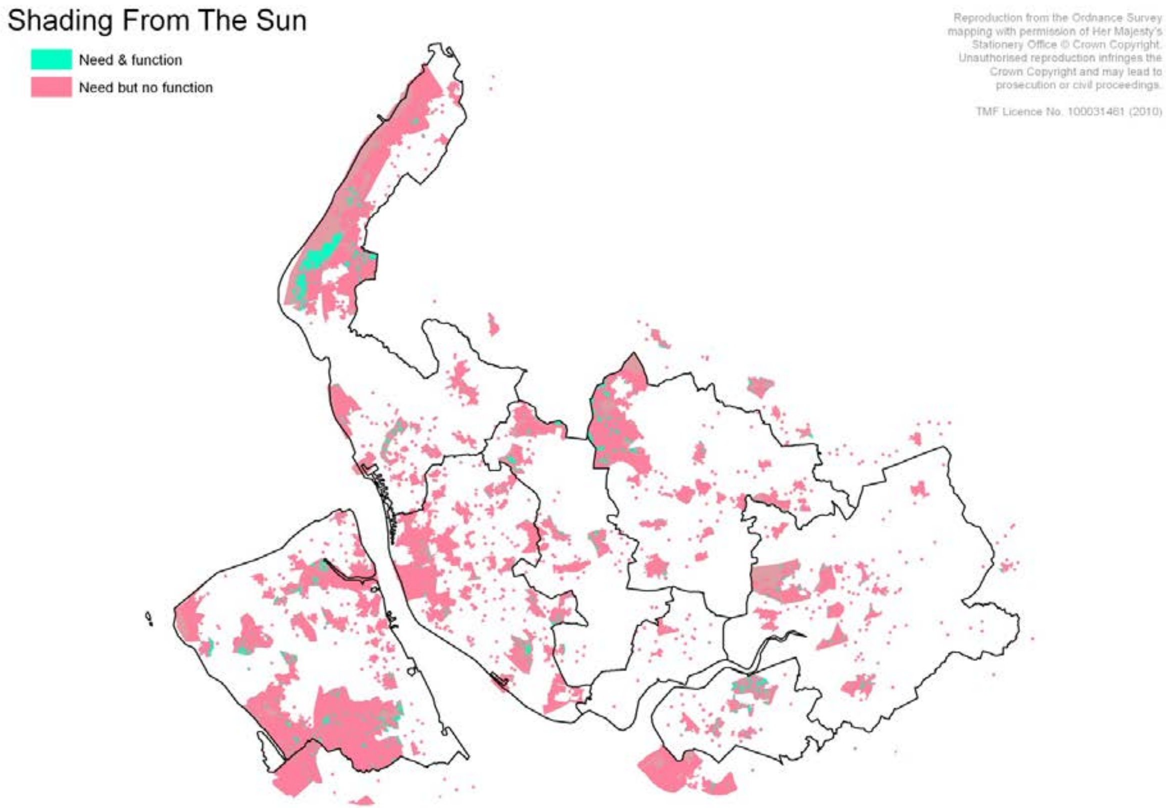


Figure 128 Soil stabilisation

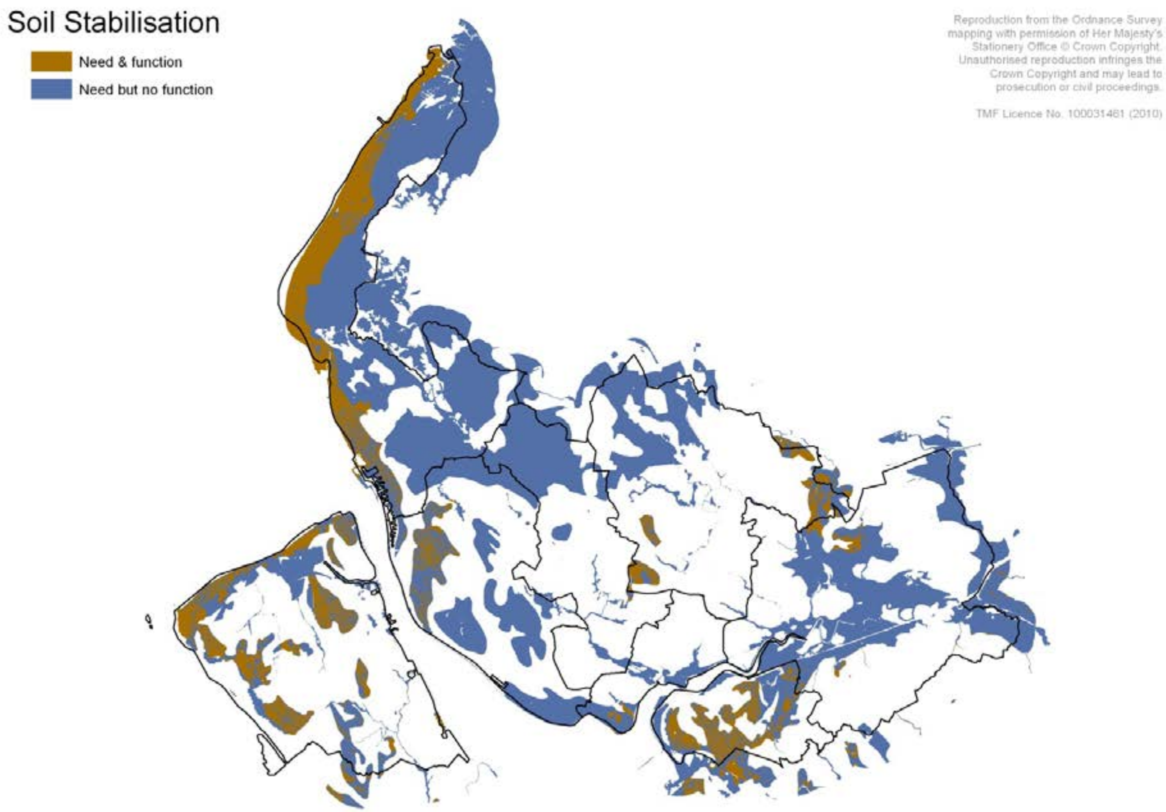


Figure 129 Timber production

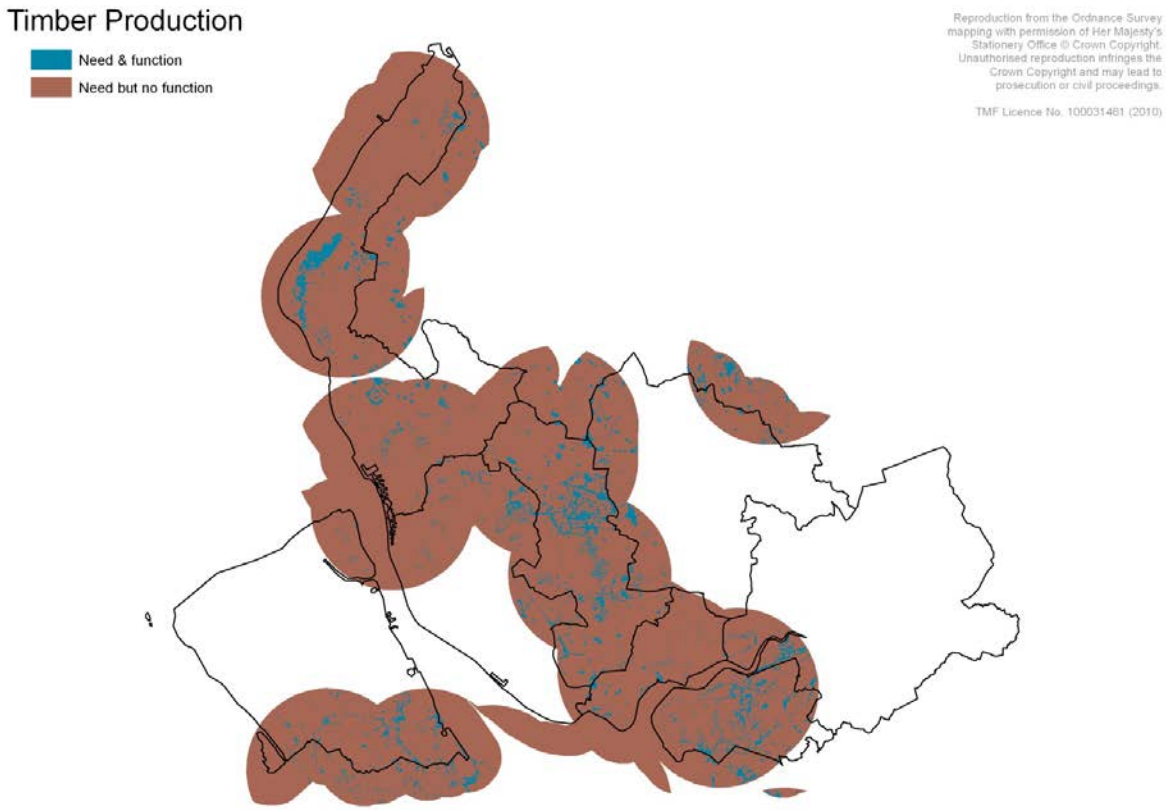


Figure 130 Trapping air pollutants

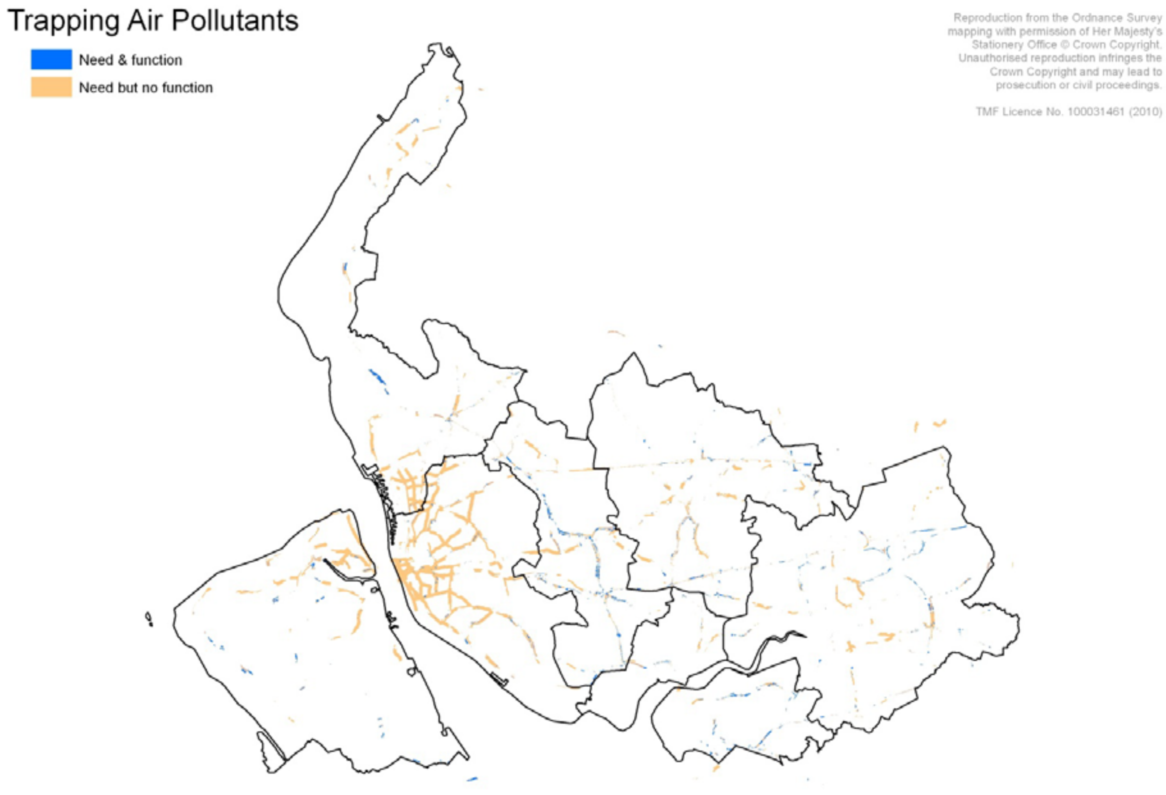


Figure 131 Water conveyance

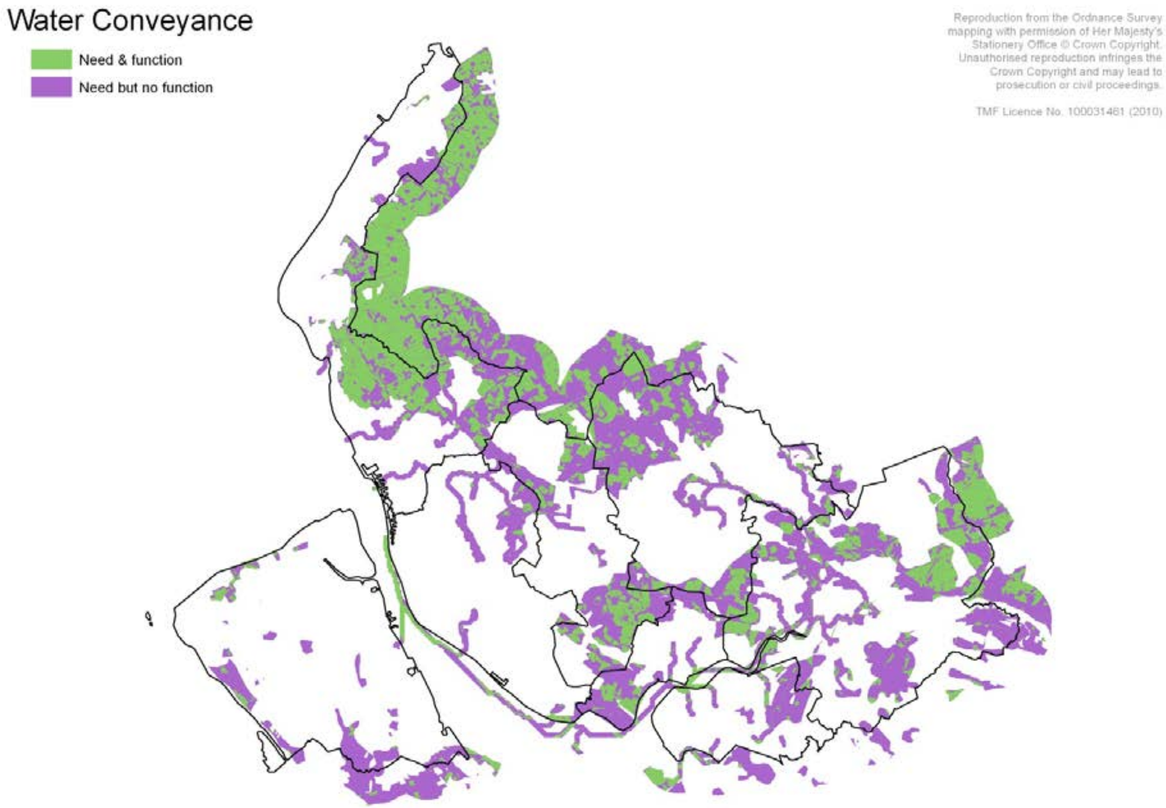


Figure 132 Water infiltration

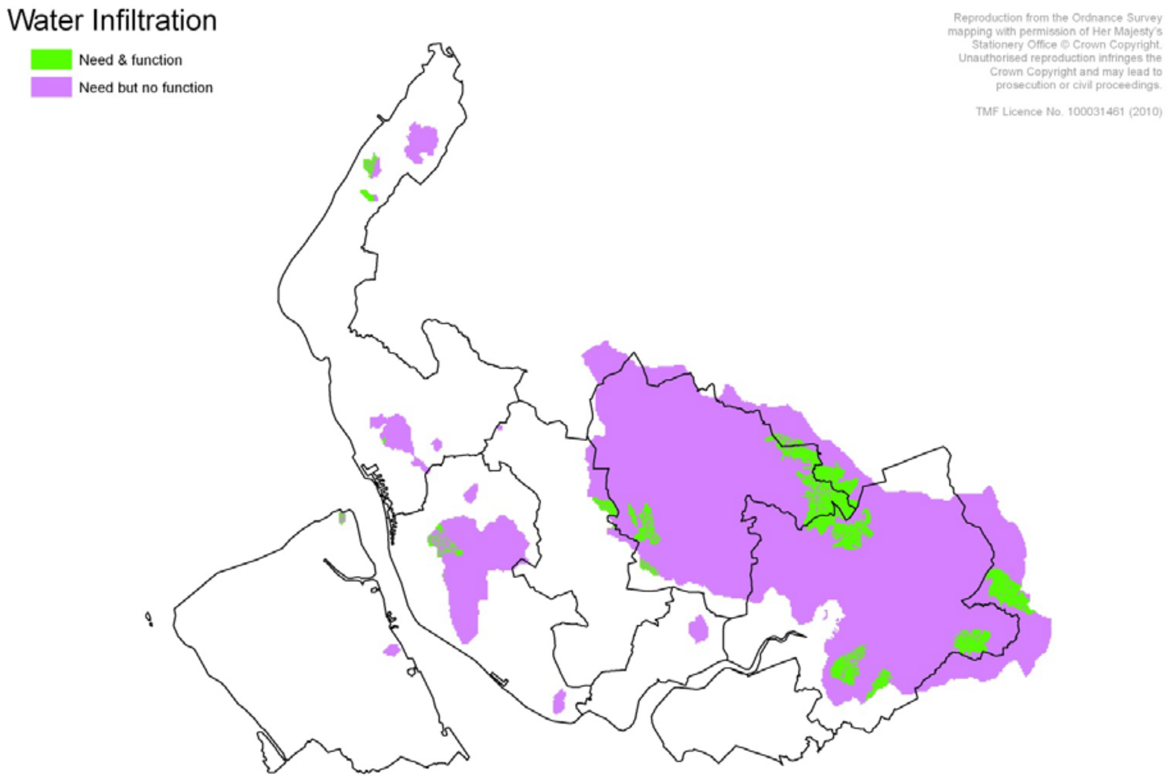


Figure 133 Water interception

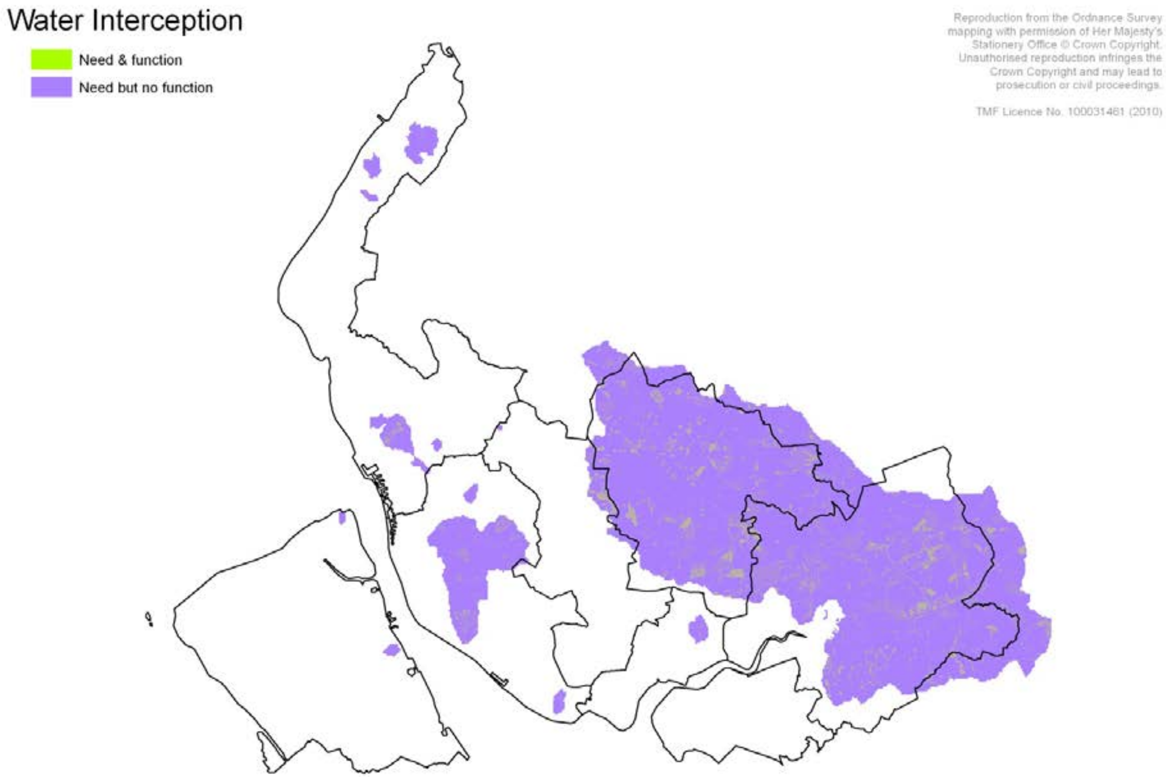


Figure 134 Wind shelter

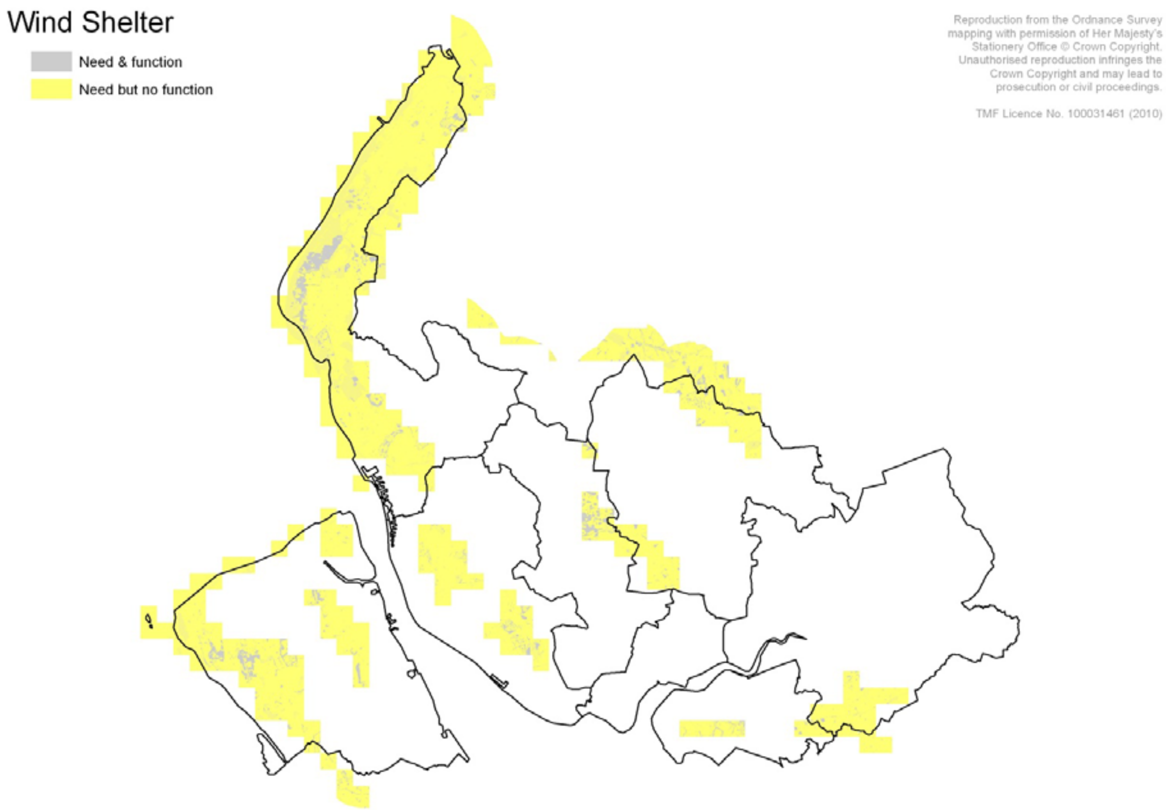


Figure 135 Total needs fulfilled

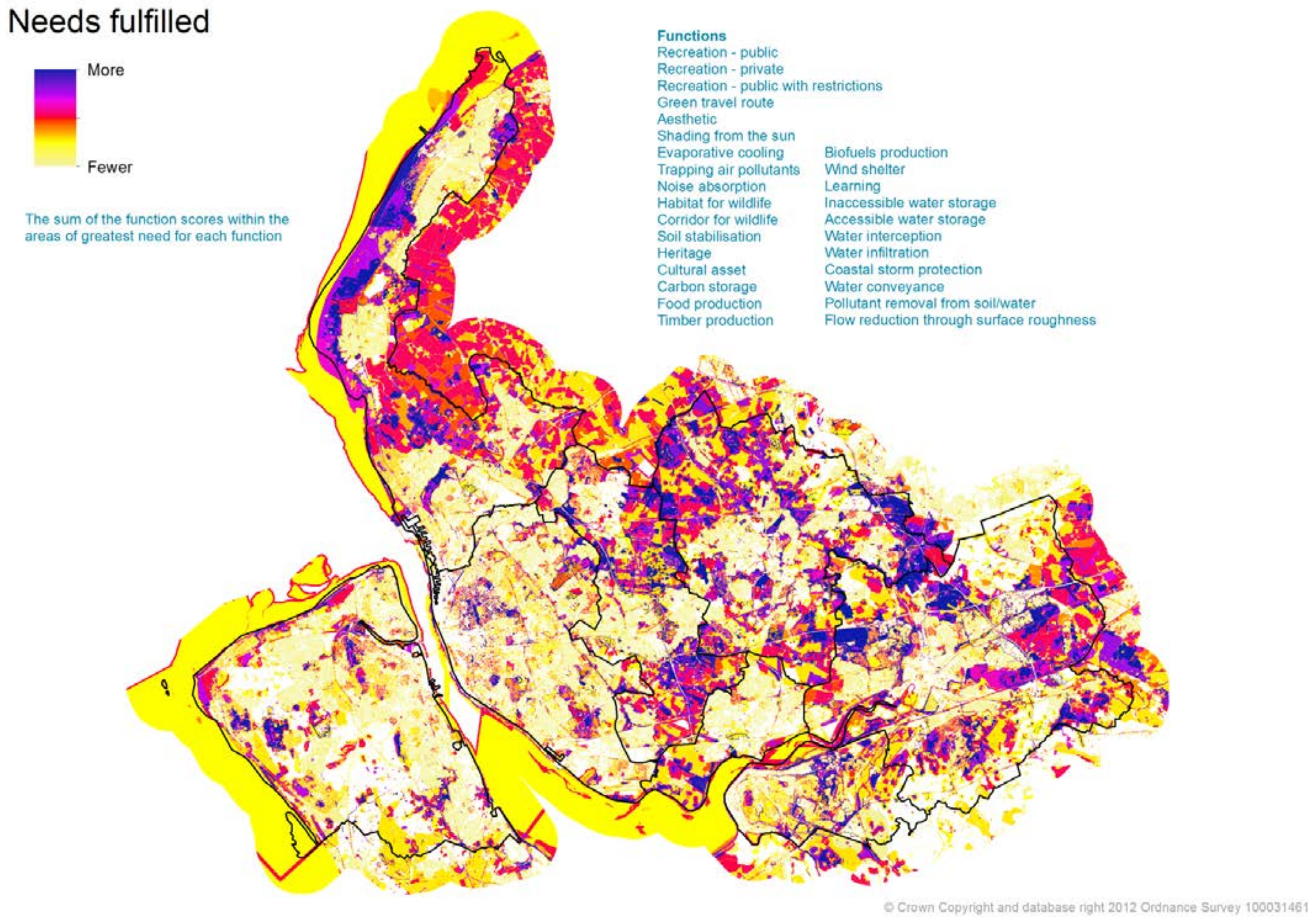


Figure 136 Total needs not fulfilled

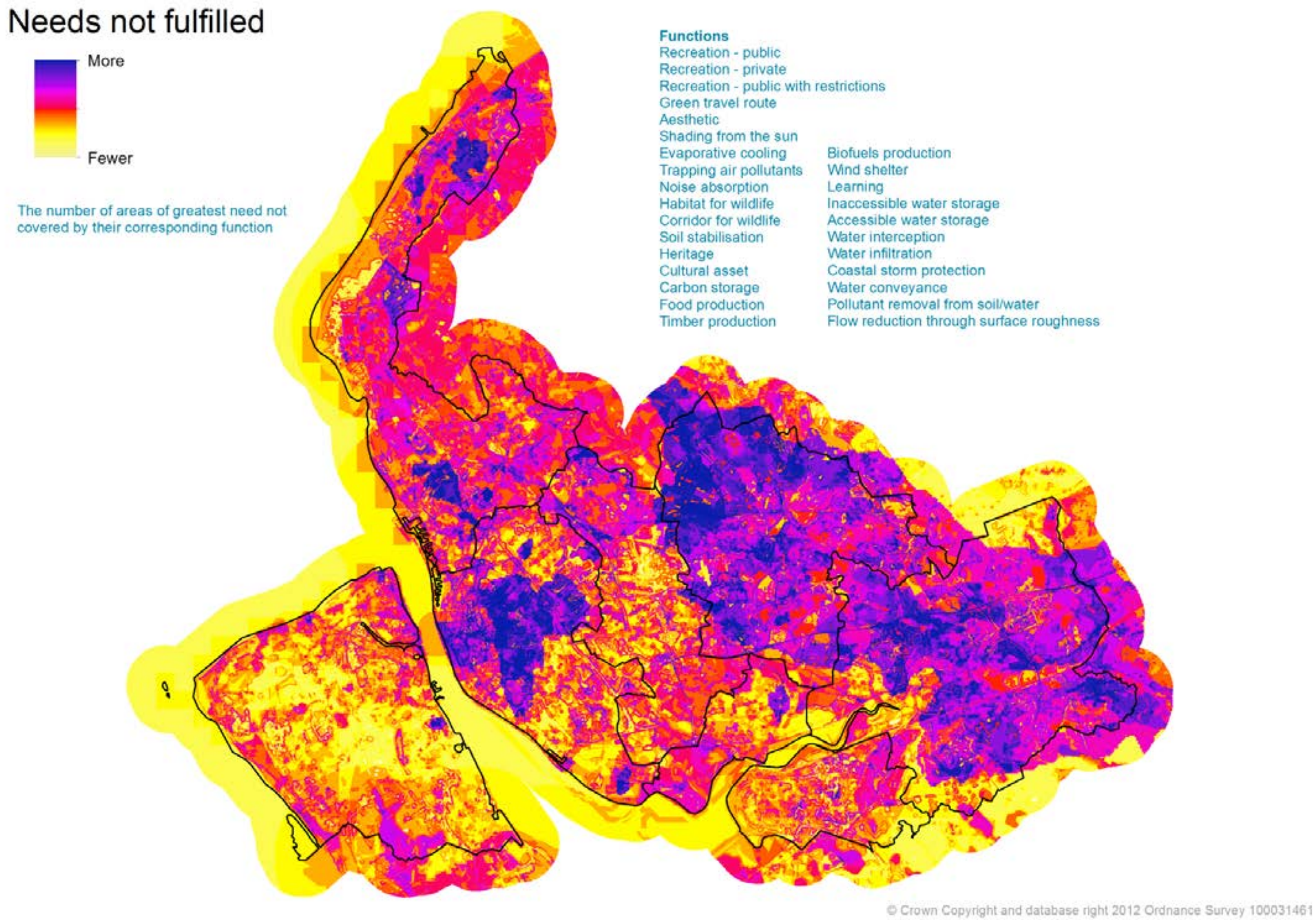


Figure 137 Needs fulfilled (excluding water functions)

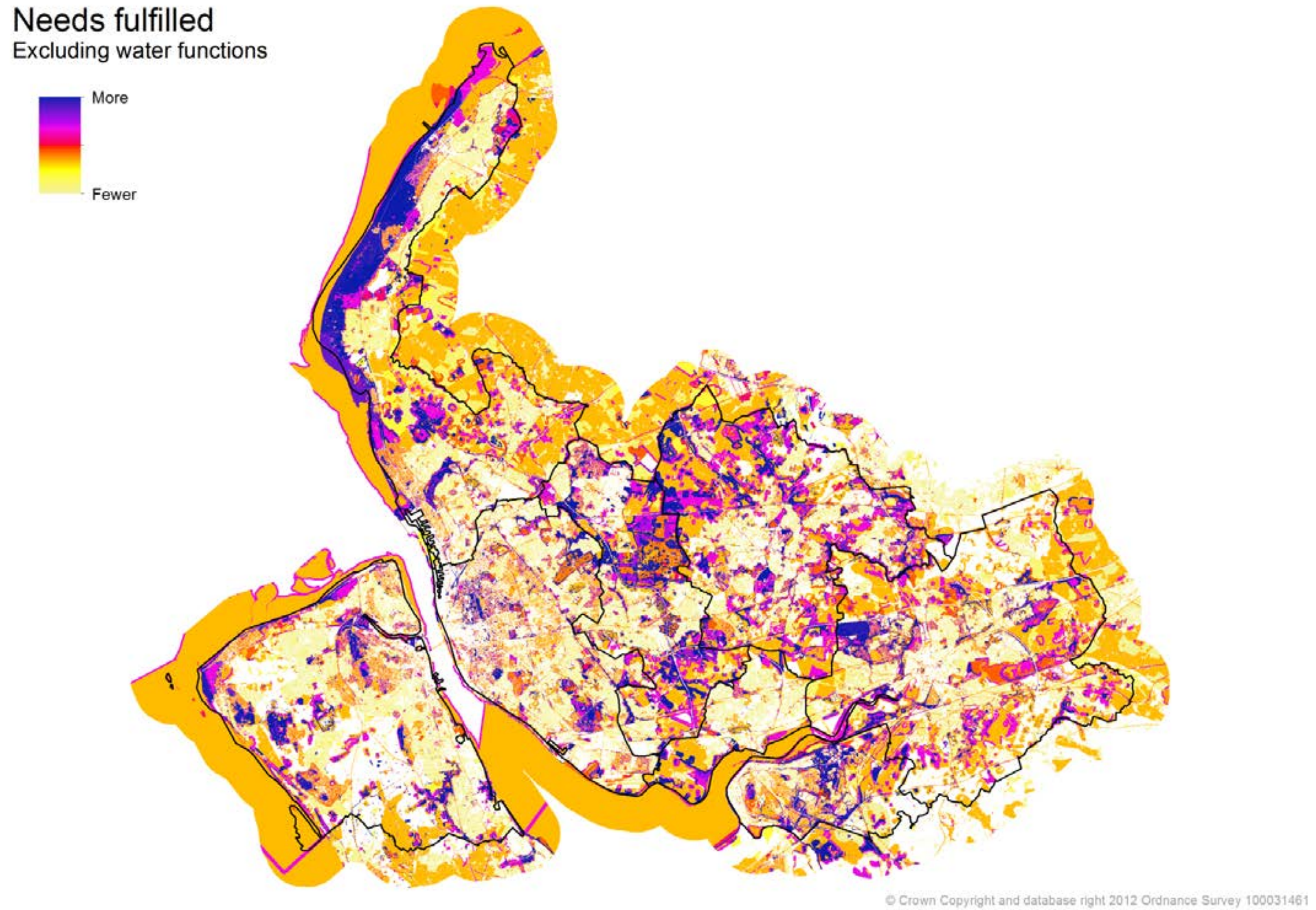


Figure 138 Needs fulfilled (water functions only)

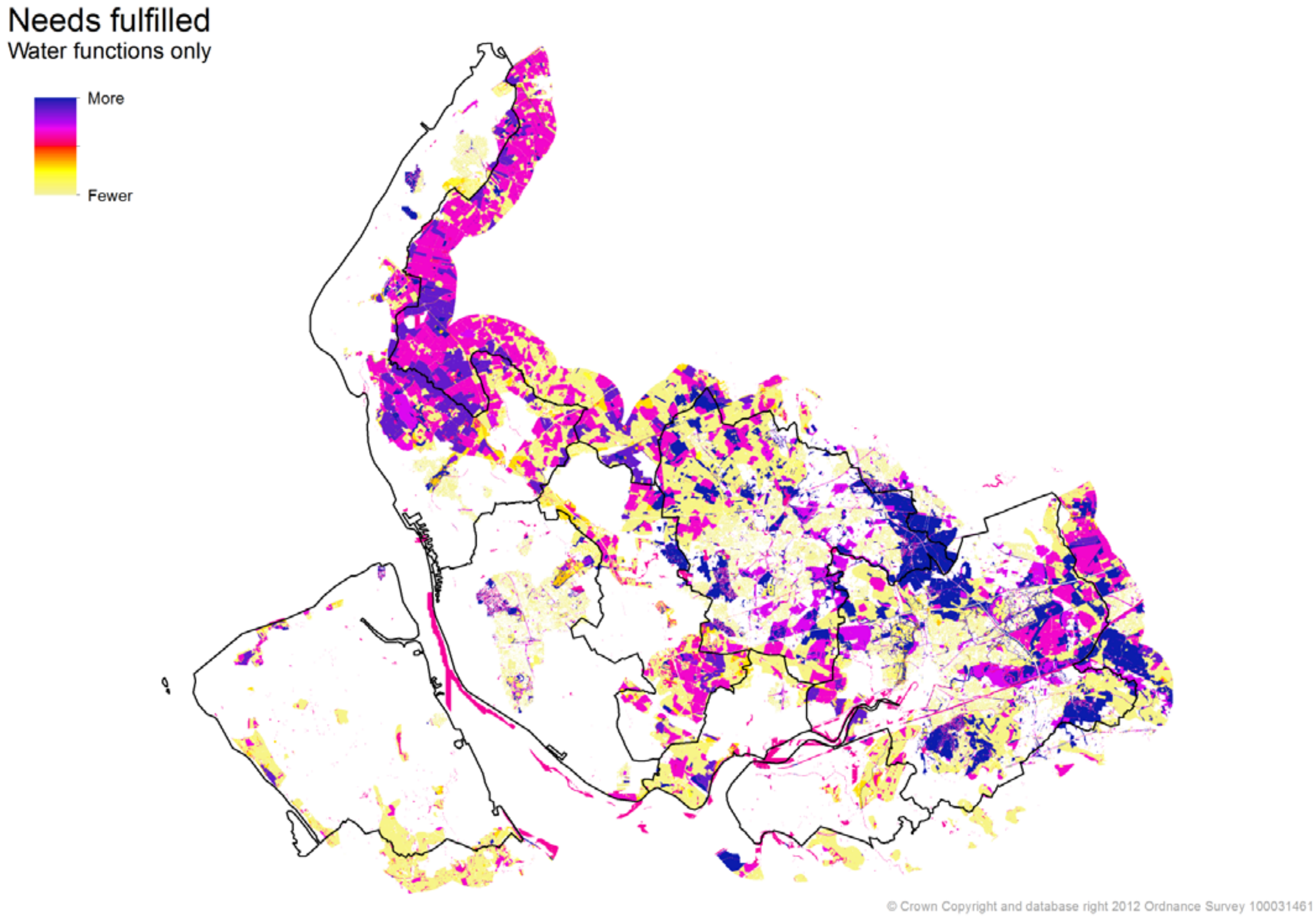


Figure 139 Needs not fulfilled (excluding water functions)

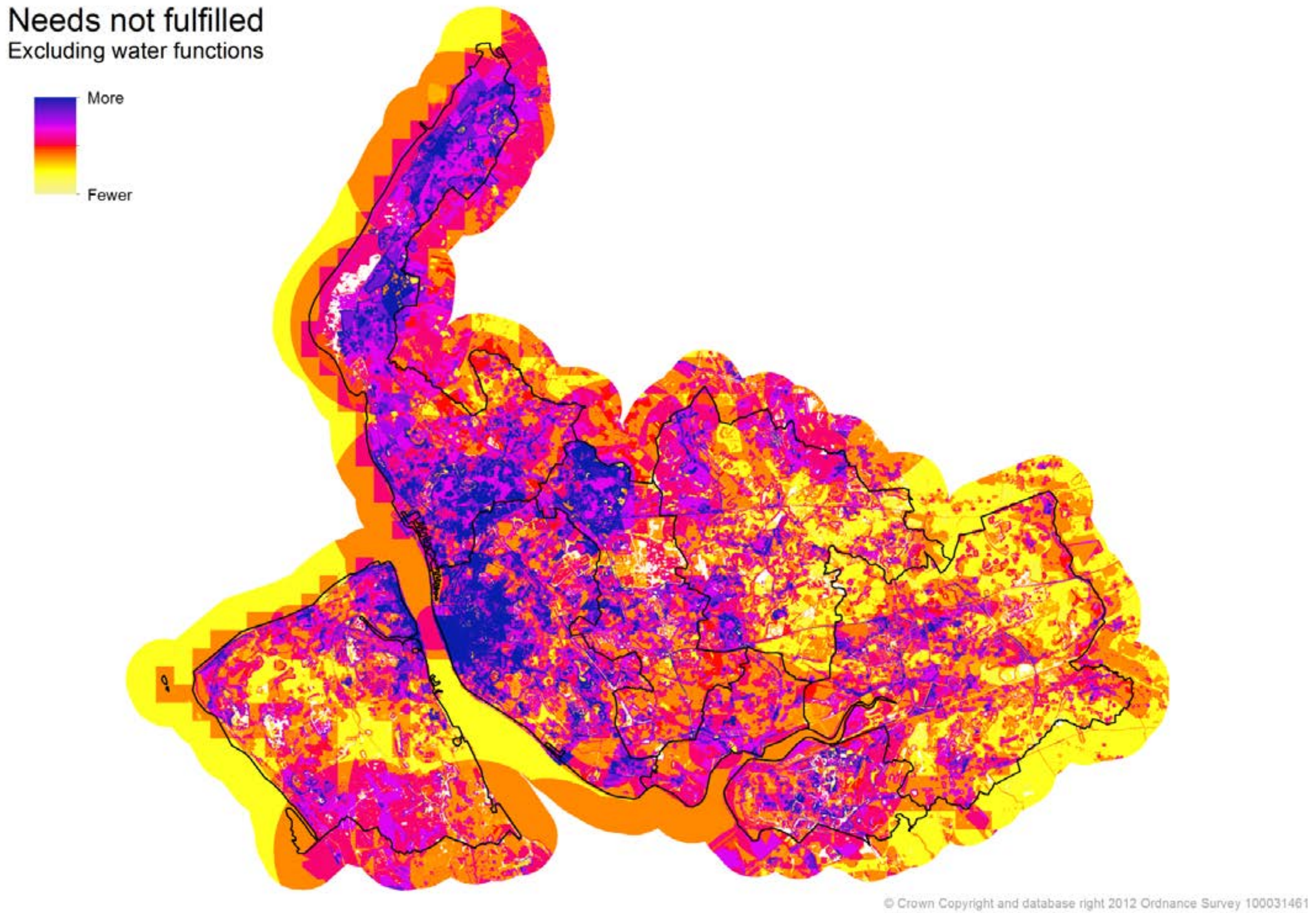


Figure 140 Needs not fulfilled (water functions only)

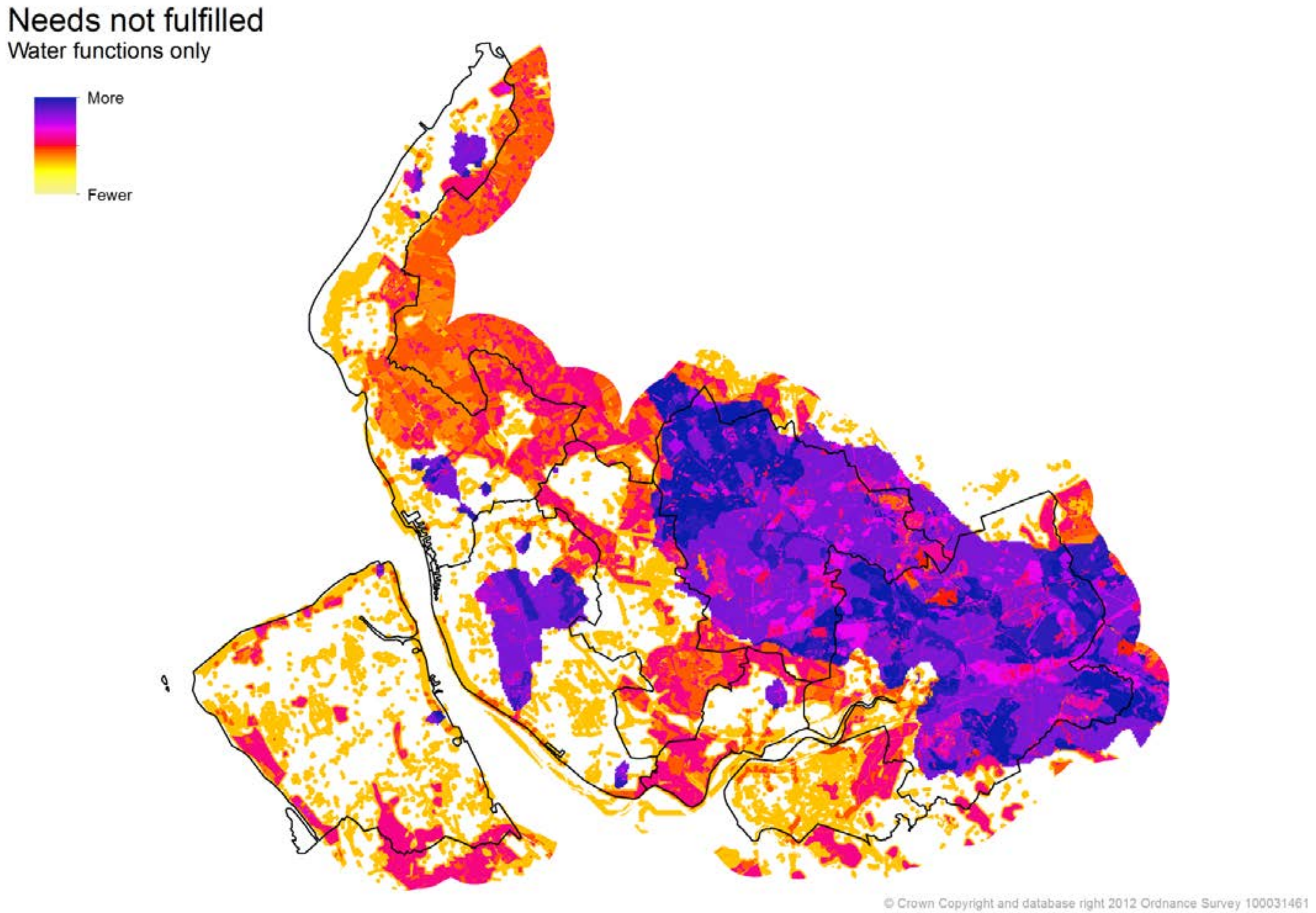


Figure 141 Developing the Rural Economy needs fulfilled

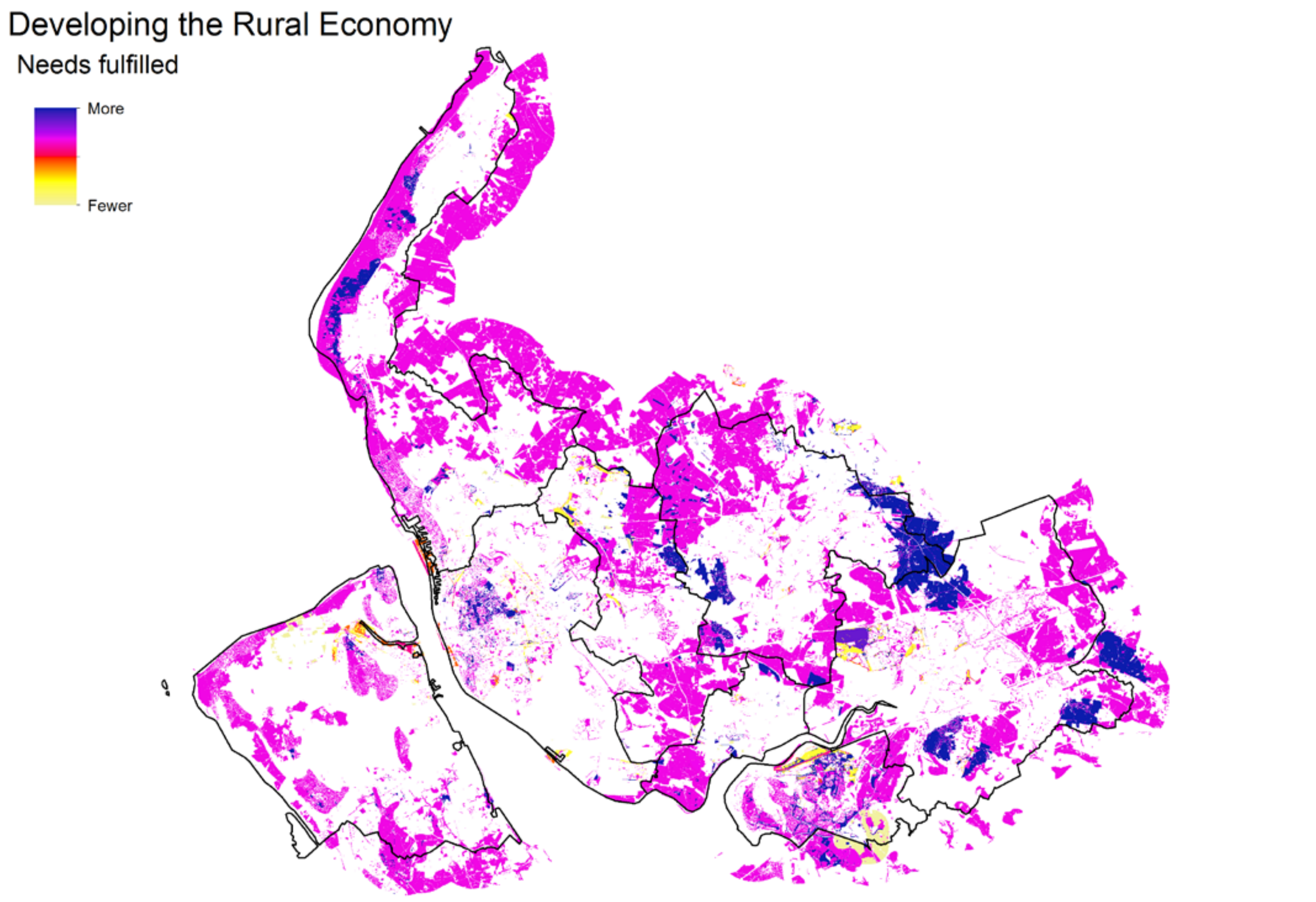


Figure 142 Enhancing the Ecological Framework needs fulfilled

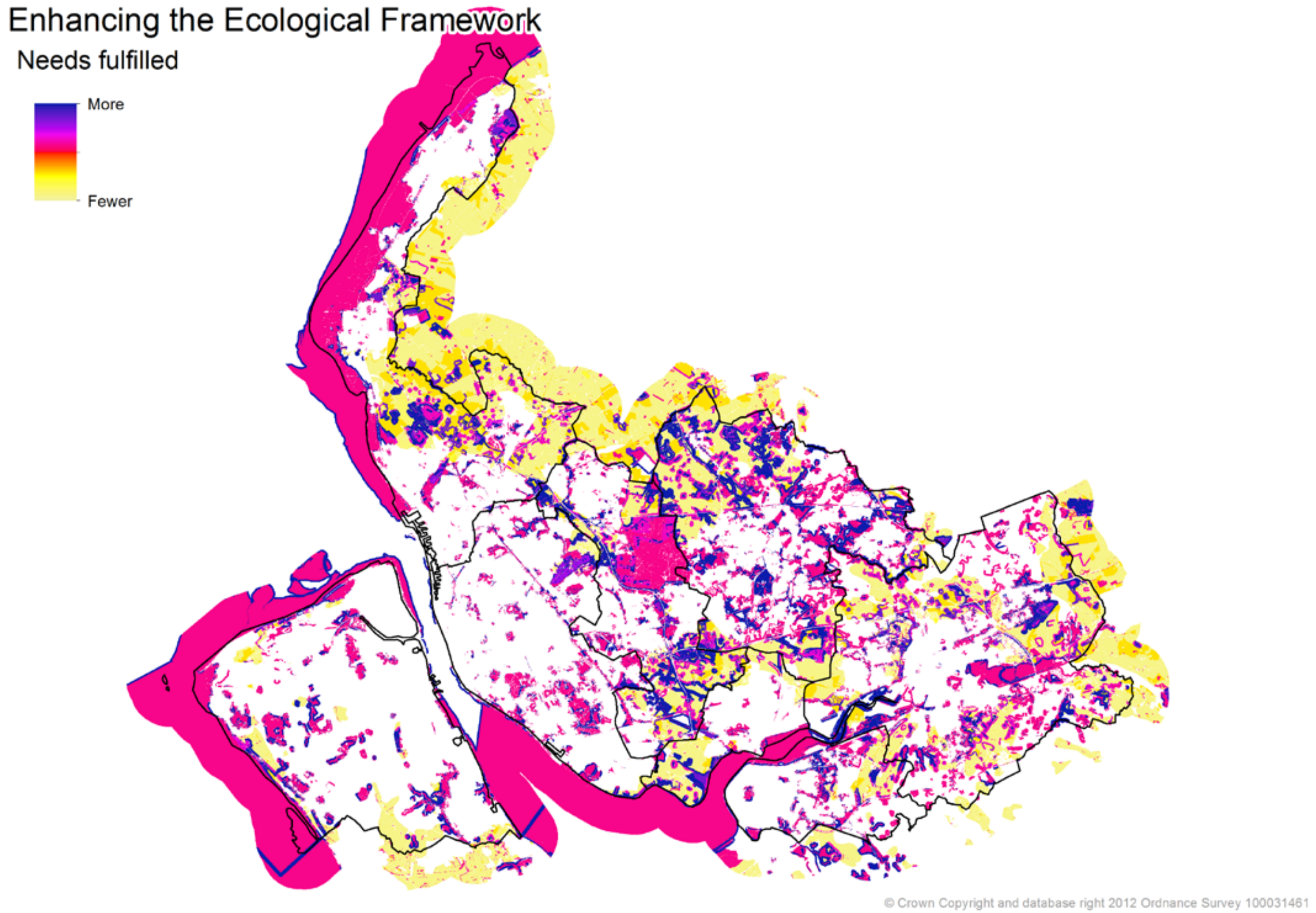


Figure 143 Providing Recreation, Leisure and Tourism needs fulfilled

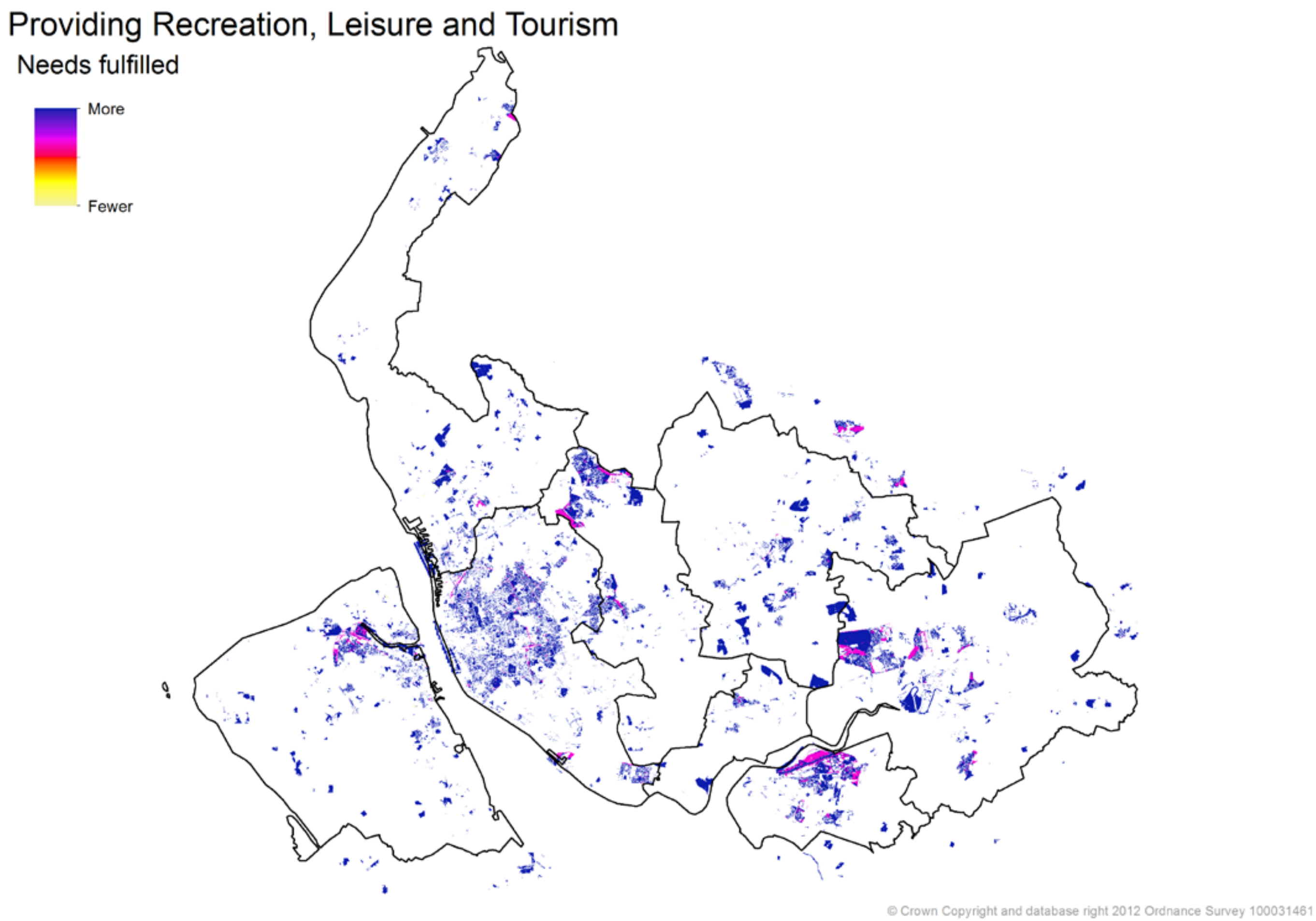


Figure 144 Setting the Scene for Growth needs fulfilled

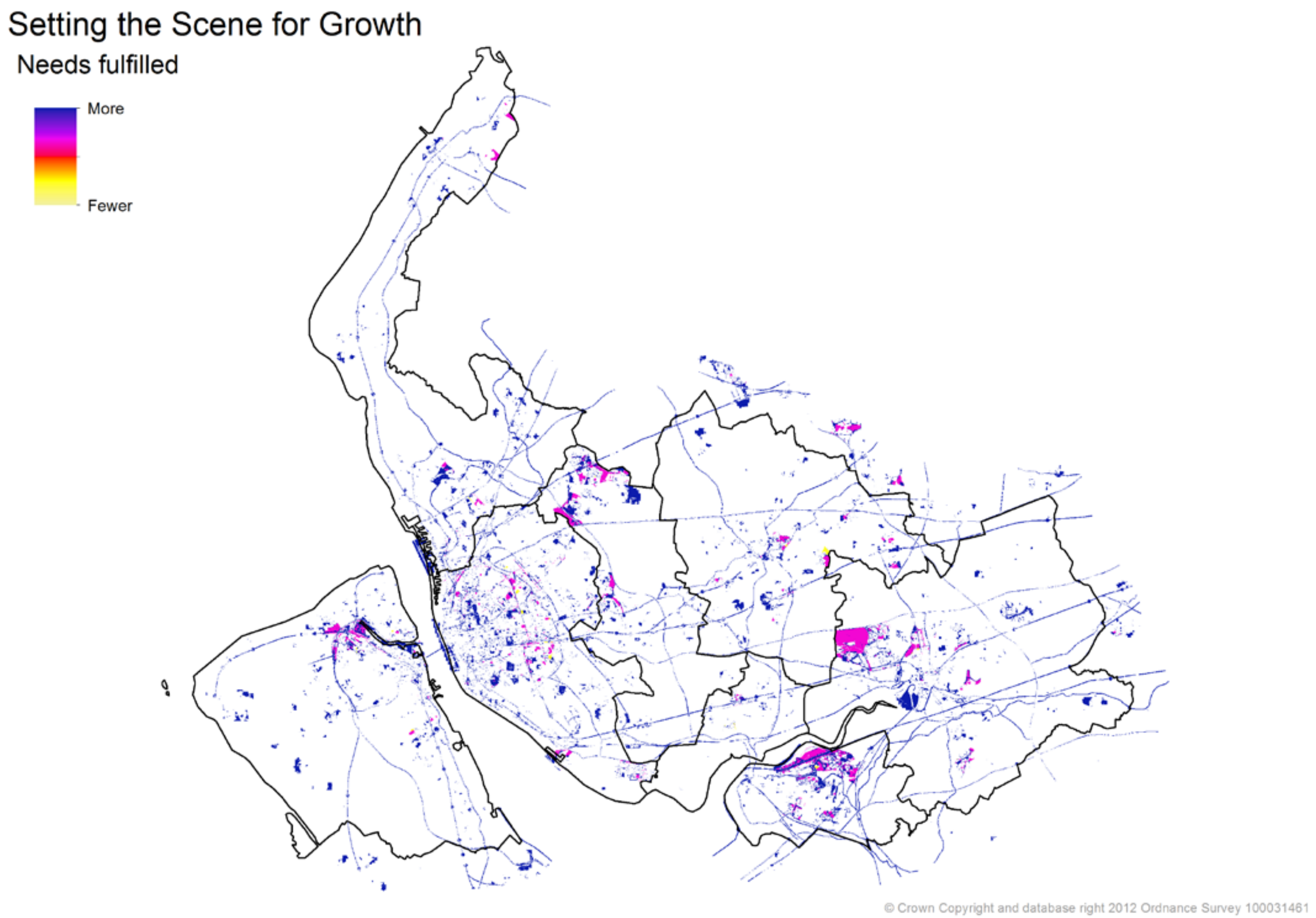


Figure 145 Supporting Adaptation to Climate Change needs fulfilled

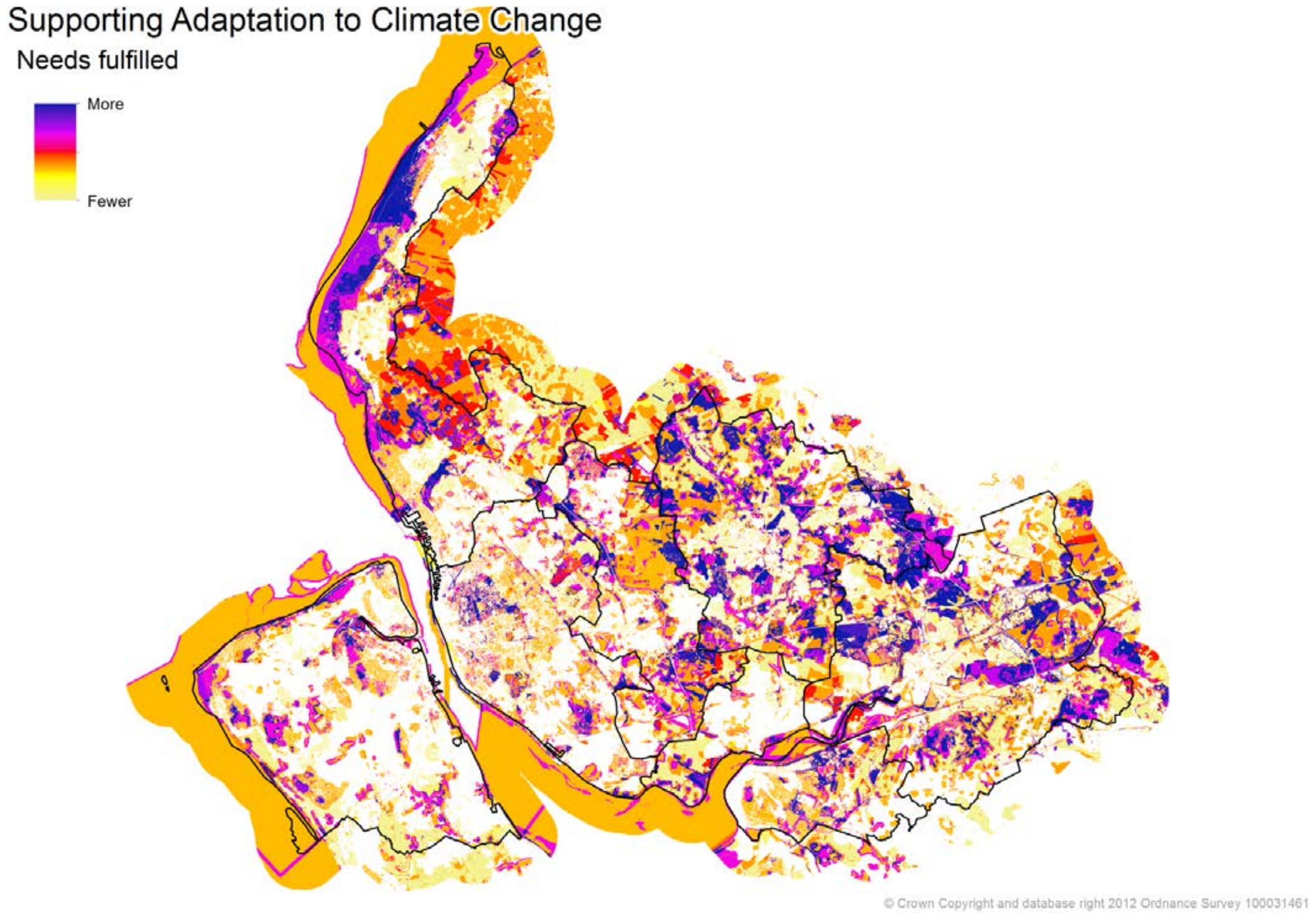


Figure 146 Supporting Health and Well-being needs fulfilled

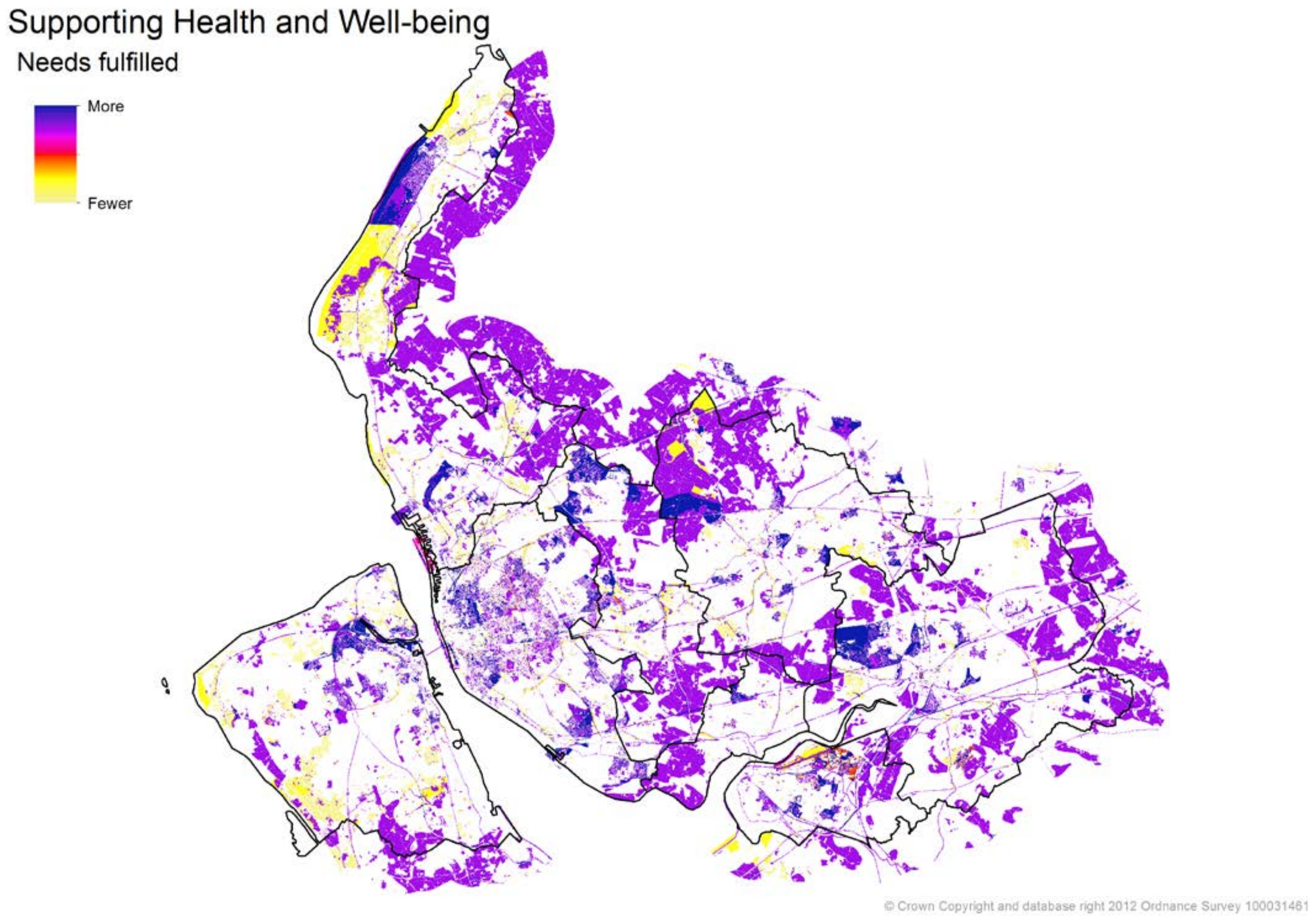


Figure 147 Developing the Rural Economy needs not fulfilled

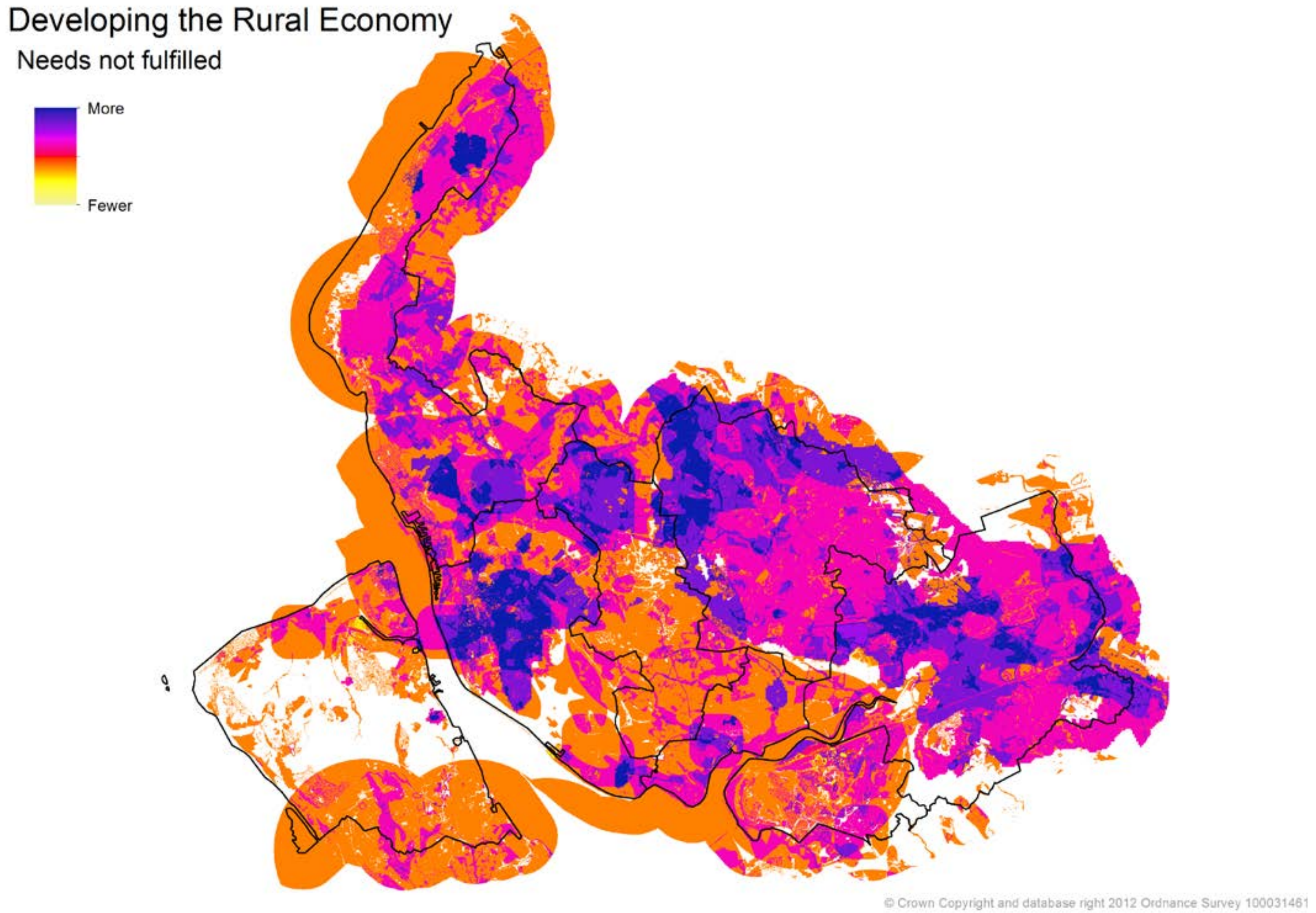


Figure 148 Enhancing the Ecological Framework needs not fulfilled

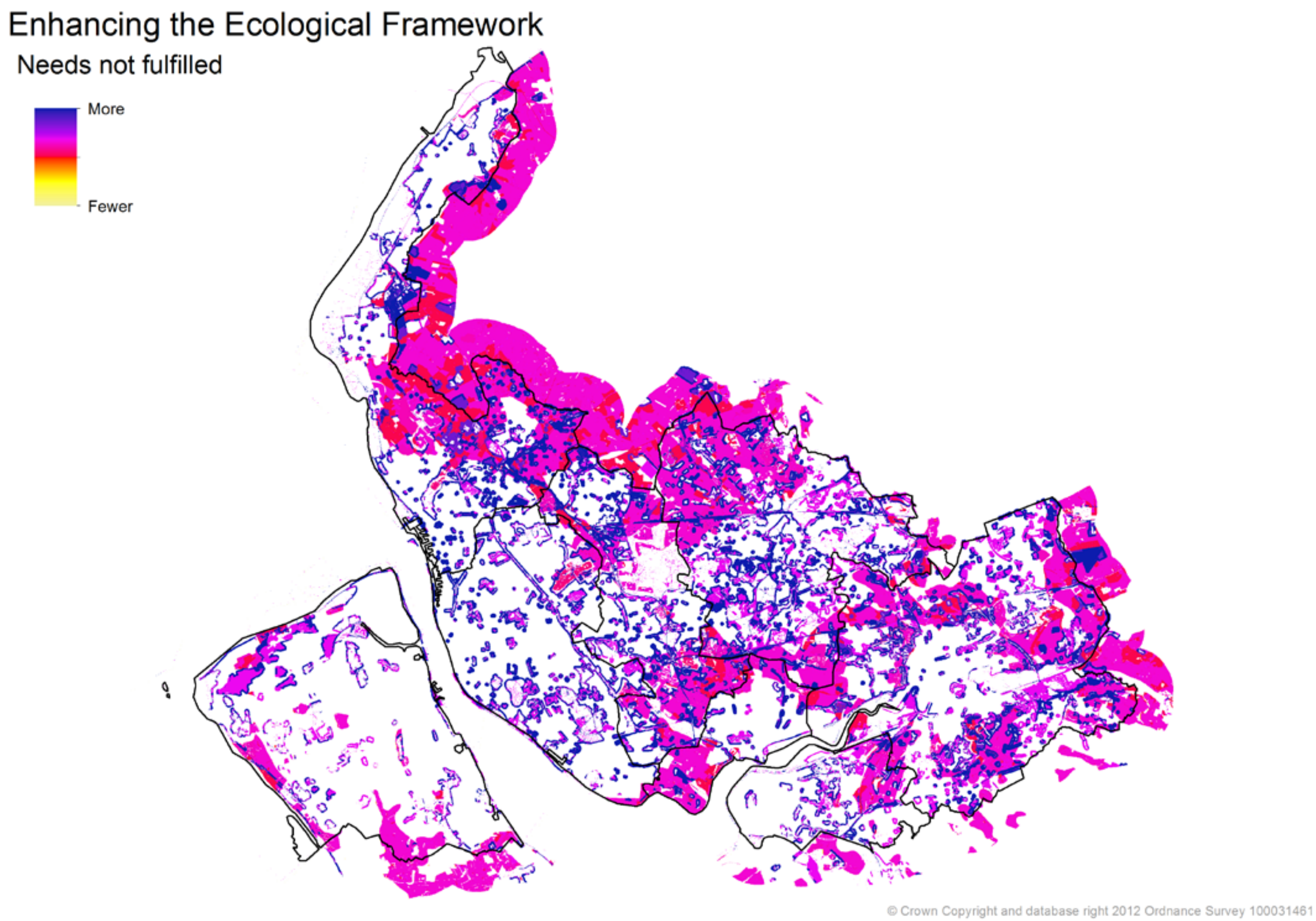


Figure 149 Providing Recreation, Leisure and Tourism needs not fulfilled

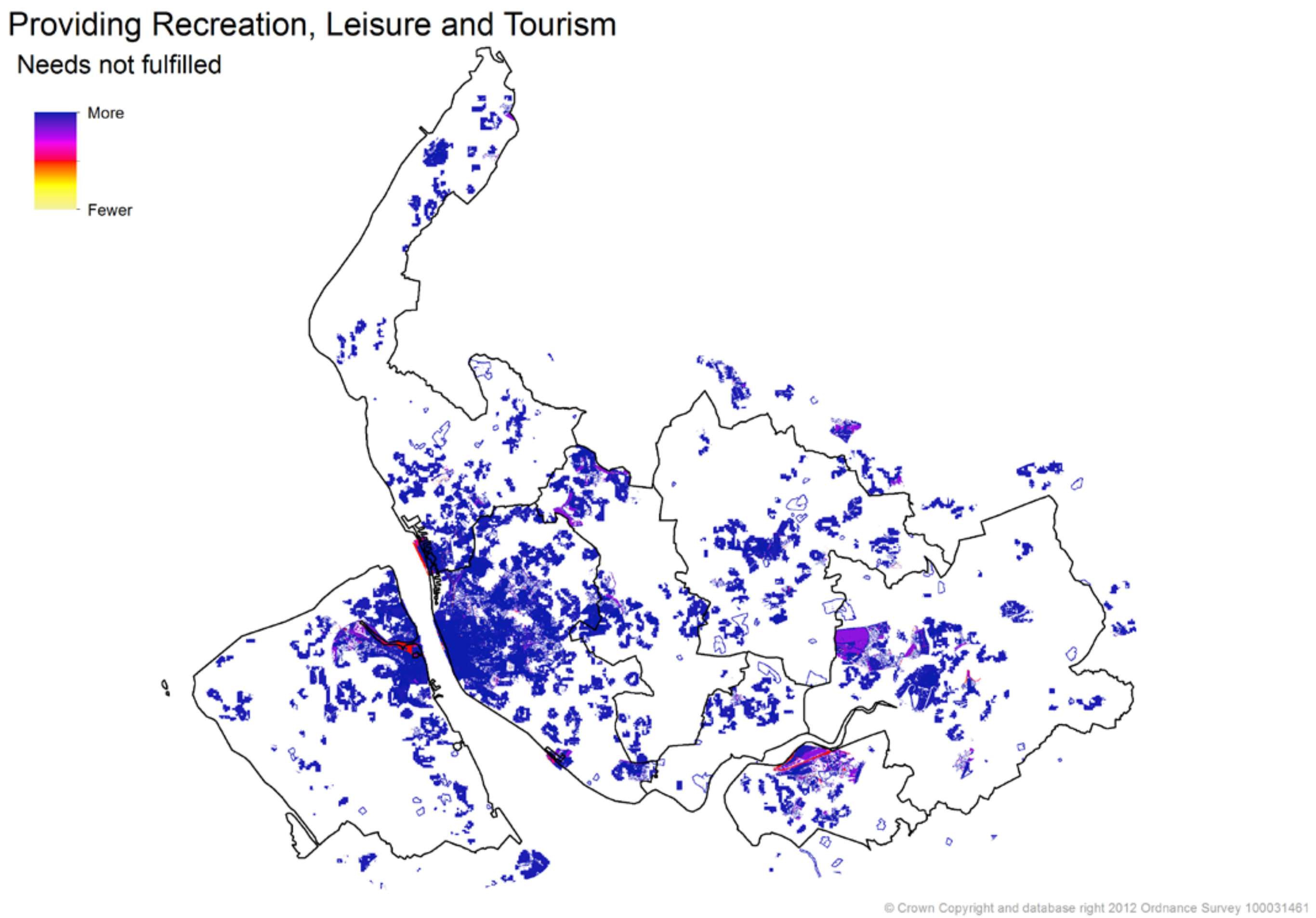


Figure 150 Setting the Scene for Growth needs not fulfilled

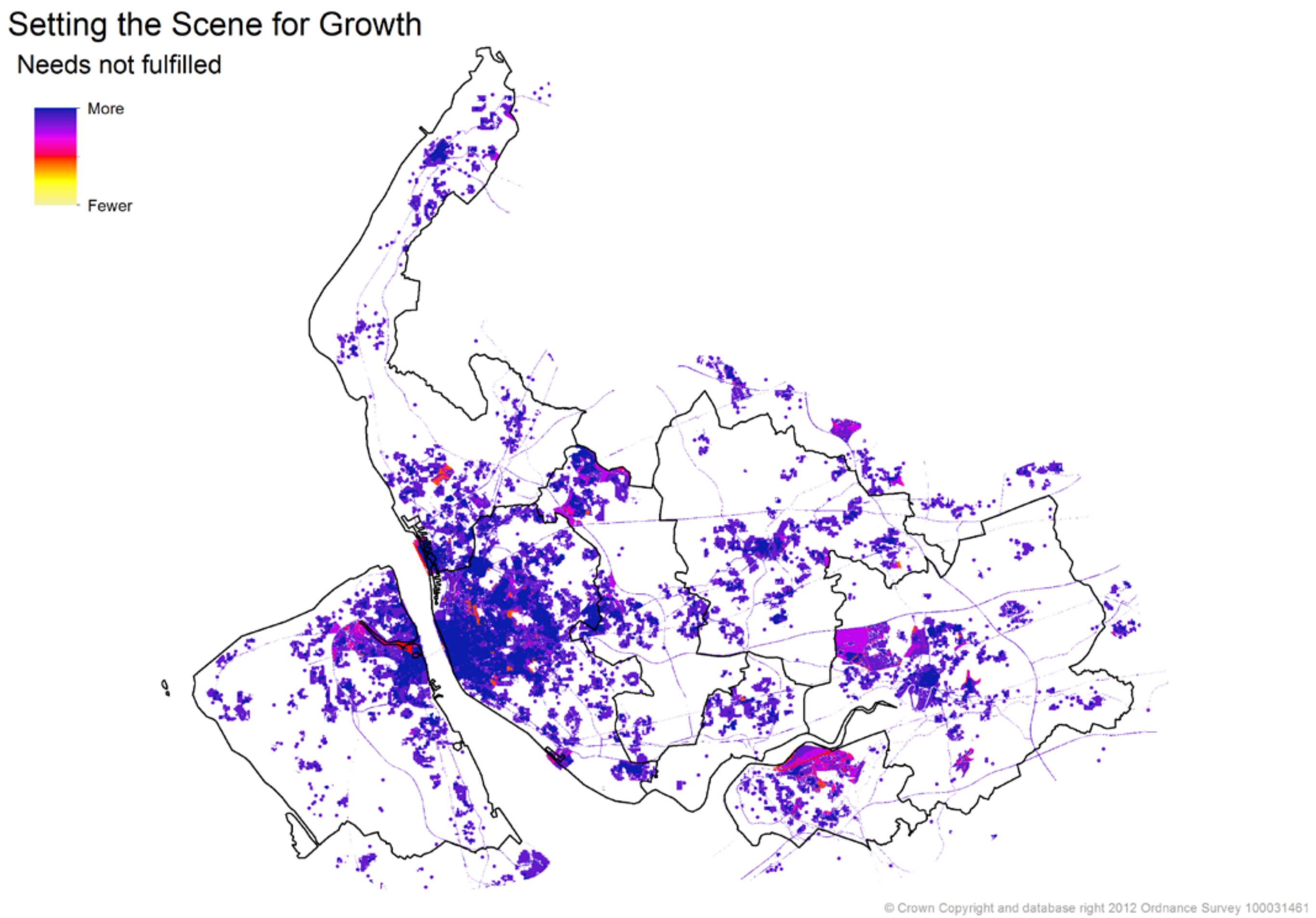


Figure 151 Supporting Adaptation to Climate Change needs not fulfilled

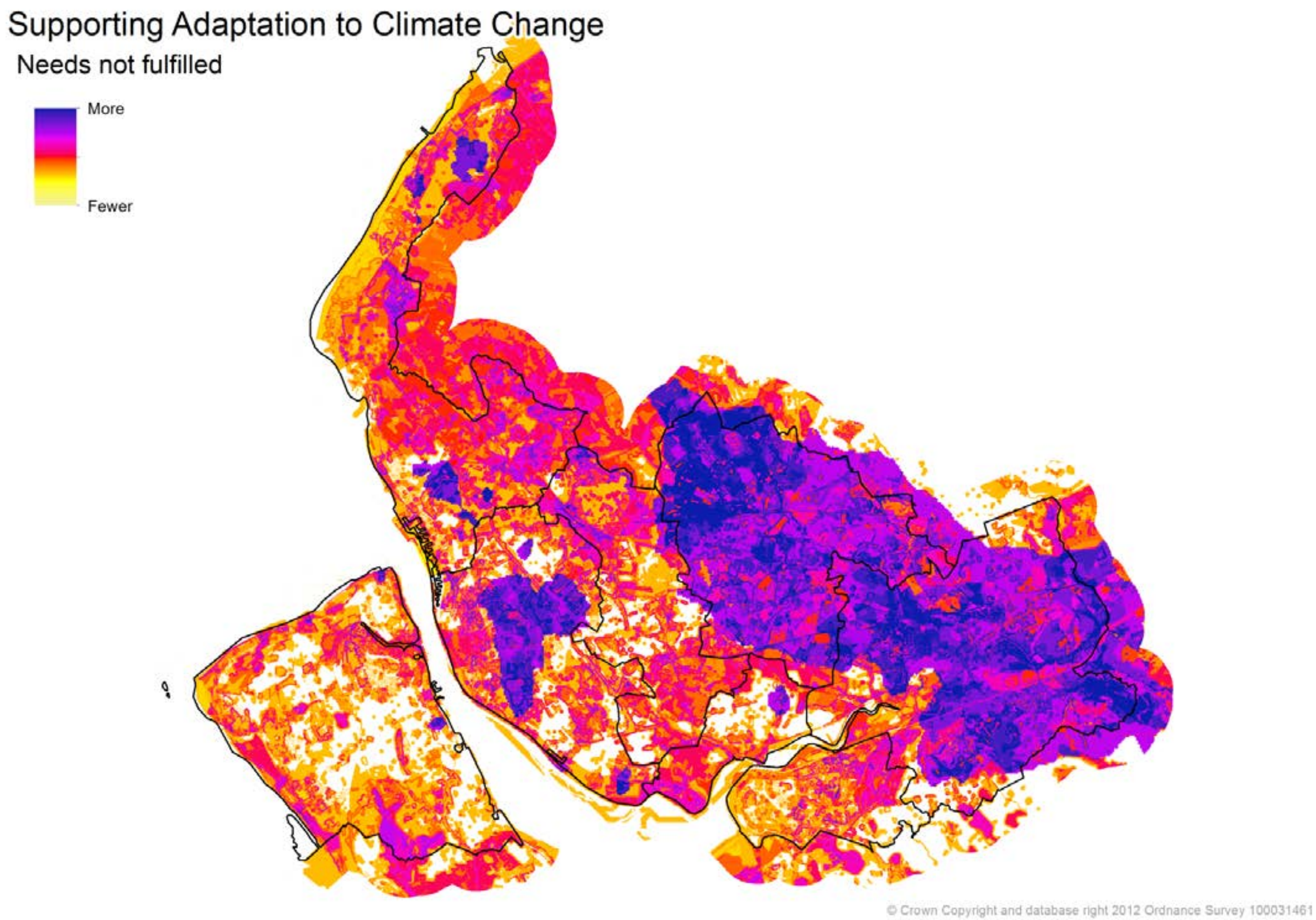


Figure 152 Supporting Health and Well-being needs not fulfilled

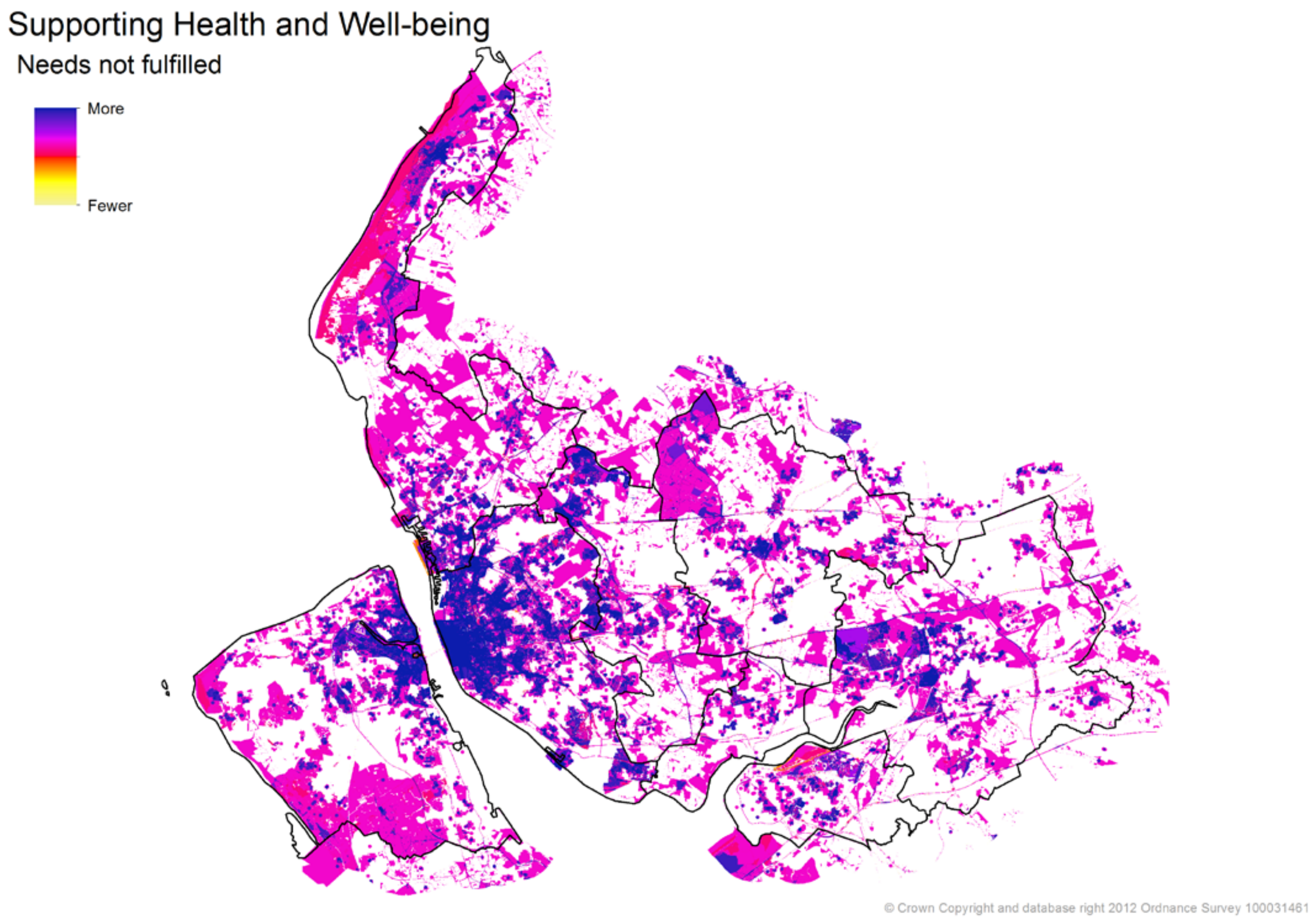
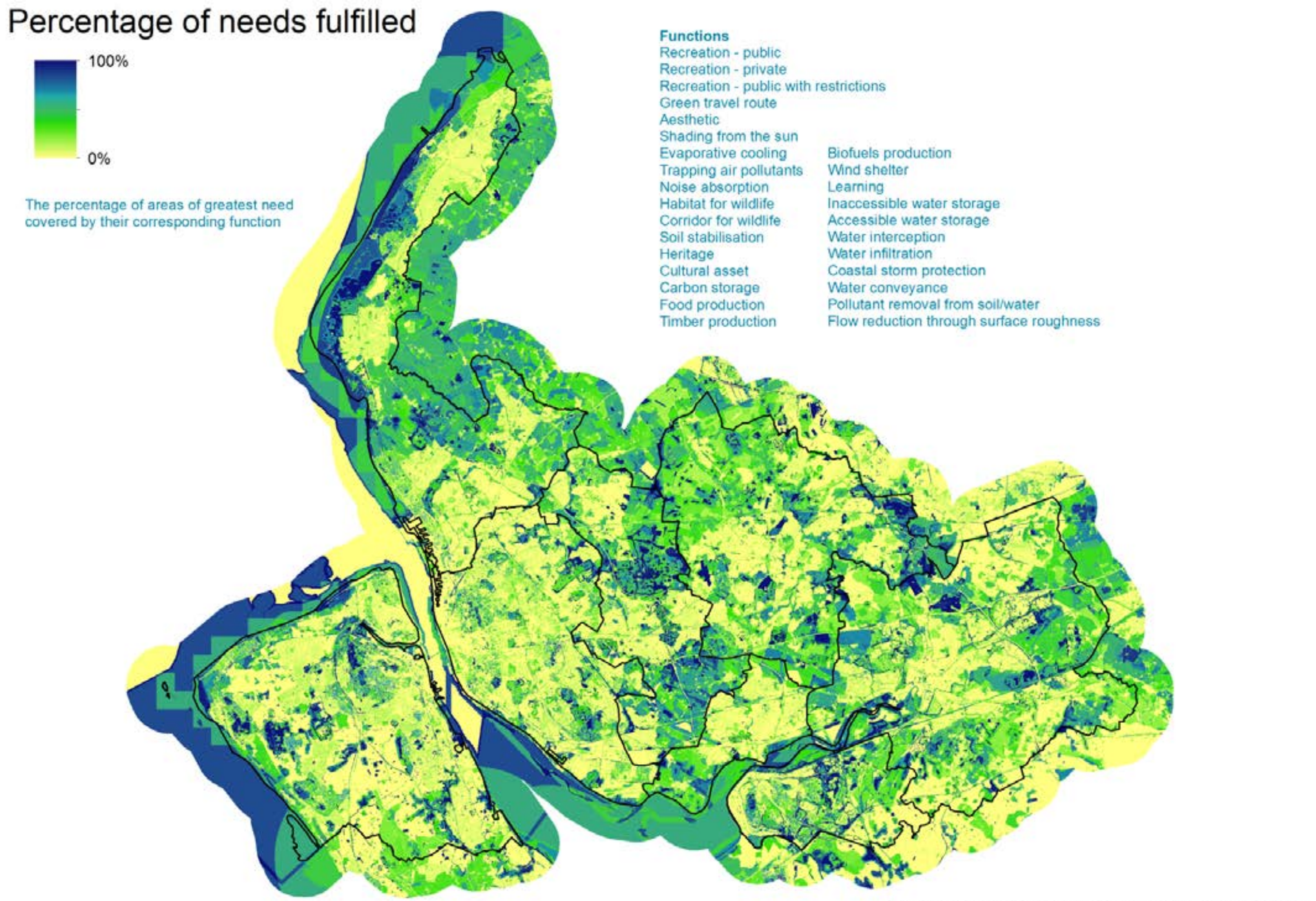


Figure 153 Percentage of needs fulfilled



18. Appendix 2 Intervention tables

The following table shows how green infrastructure interventions can help to overcome each of the categories of 'pinch' (see page 162).

Suggested GI intervention	Risk of flooding	Risk of loss of carbon storage	Risk of loss of biodiversity	Risk of urban heat island effect	Risk of coastal storms	Risk of poor air quality	Risk of inadequate non-portable water supply	Risk of soil erosion	Risk to tourism growth	Risk of poor recreation resource	Risk of poor aesthetic s	Risk of little green travel	Risk of noise	Risk of poor green infrastructure support for heritage resource	Risk of poor green infrastructure support for cultural resource
Increase tree cover on site	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Select a mixture of native species (to provide food and habitat for wildlife)			x								x				
Select species to improve air quality		x				x									
Select species to provide shade (e.g. that will have large canopies when mature) and plant in areas where people walk and gather				x					x	x		x			

Suggested GI intervention	Risk of flooding	Risk of loss of carbon storage	Risk of loss of biodiversity	Risk of urban heat island effect	Risk of coastal storms	Risk of poor air quality	Risk of inadequate non-portable water supply	Risk of soil erosion	Risk to tourism growth	Risk of poor recreation resource	Risk of poor aesthetic s	Risk of little green travel	Risk of noise	Risk of poor green infrastructure support for heritage resource	Risk of poor green infrastructure support for cultural resource
Select broadleaf species and plant to provide shade to buildings (e.g. on south facing facades)				x							x				
Select species with large canopies to capture rainwater	x				x										
Select species (e.g. conifers) and plant to provide wind shelter					x				x			x			
Select species and plant for aesthetic quality / image and to provide visual screening									x		x			x	x
Select species to provide fruit and nuts			x												
Planted in streets											x	x			

Suggested GI intervention	Risk of flooding	Risk of loss of carbon storage	Risk of loss of biodiversity	Risk of urban heat island effect	Risk of coastal storms	Risk of poor air quality	Risk of inadequate non-portable water supply	Risk of soil erosion	Risk to tourism growth	Risk of poor recreation resource	Risk of poor aesthetic s	Risk of little green travel	Risk of noise	Risk of poor green infrastructure support for heritage resource	Risk of poor green infrastructure support for cultural resource
Retain existing mature trees on site			x											x	
Planted along streams, rivers and on floodplains	x							x		x					
Select and manage species to provide carbon sequestration and storage		x			X										
Plant trees to stabilise slopes and soils vulnerable to erosion	x							x							
Plant trees as part of a sound barrier									x				x		
Manage trees on site as a timber and/or fuel resource															x

Suggested GI intervention	Risk of flooding	Risk of loss of carbon storage	Risk of loss of biodiversity	Risk of urban heat island effect	Risk of coastal storms	Risk of poor air quality	Risk of inadequate non-portable water supply	Risk of soil erosion	Risk to tourism growth	Risk of poor recreation resource	Risk of poor aesthetics	Risk of little green travel	Risk of noise	Risk of poor green infrastructure support for heritage resource	Risk of poor green infrastructure support for cultural resource
Install green roofs	x	x	x	x	x	x		x		x	x			x	x
Designed to capture rainwater	x														
Design green roofs to increase biodiversity (e.g. using a variety of substrates, differing depths, and selecting species appropriately)			x												
Design green roofs to allow access by people									x	x				x	x
Grow food crops			x												x
Install on buildings which are overlooked for aesthetic purposes											x				

Suggested GI intervention	Risk of flooding	Risk of loss of carbon storage	Risk of loss of biodiversity	Risk of urban heat island effect	Risk of coastal storms	Risk of poor air quality	Risk of inadequate non-portable water supply	Risk of soil erosion	Risk to tourism growth	Risk of poor recreation resource	Risk of poor aesthetic s	Risk of little green travel	Risk of noise	Risk of poor green infrastructure support for heritage resource	Risk of poor green infrastructure support for cultural resource
Install green walls	x	x	x	x		x					x		x		
Plant to provide shade to buildings (e.g. on south facing facades); reducing direct solar gain in summer, use species to allow for solar gain in winter				x											
Plant to increase biodiversity (e.g. species to provide food and habitat)			x												
Grow food crops			x												x

Suggested GI intervention	Risk of flooding	Risk of loss of carbon storage	Risk of loss of biodiversity	Risk of urban heat island effect	Risk of coastal storms	Risk of poor air quality	Risk of inadequate non-portable water supply	Risk of soil erosion	Risk to tourism growth	Risk of poor recreation resource	Risk of poor aesthetic s	Risk of little green travel	Risk of noise	Risk of poor green infrastructure support for heritage resource	Risk of poor green infrastructure support for cultural resource
Plant to improve aesthetic quality or image									x		x				

Suggested GI intervention	Risk of flooding	Risk of loss of carbon storage	Risk of loss of biodiversity	Risk of urban heat island effect	Risk of coastal storms	Risk of poor air quality	Risk of inadequate non-portable water supply	Risk of soil erosion	Risk to tourism growth	Risk of poor recreation resource	Risk of poor aesthetics	Risk of little green travel	Risk of noise	Risk of poor green infrastructure support for heritage resource	Risk of poor green infrastructure support for cultural resource
General vegetation-related interventions	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Increase green cover on site	x	x	x		x					x	x			x	x
Design green infrastructure on site to provide a variety of micro-climates for users (e.g. access to sun, shade, wind, shelter)			x						x	x	x	x			
Plant vegetation to stabilise slopes and soils vulnerable to erosion					x			x							
Safeguard wildlife habitats on site, referring to Biodiversity Action Plans			x												

Suggested GI intervention	Risk of flooding	Risk of loss of carbon storage	Risk of loss of biodiversity	Risk of urban heat island effect	Risk of coastal storms	Risk of poor air quality	Risk of inadequate non-portable water supply	Risk of soil erosion	Risk to tourism growth	Risk of poor recreation resource	Risk of poor aesthetics	Risk of little green travel	Risk of noise	Risk of poor green infrastructure support for heritage resource	Risk of poor green infrastructure support for cultural resource
Create new habitats on site, including ponds	x		x		x		x								
Select vegetation to provide food for wildlife e.g. nectar rich plants			x												
Plant a diverse mixture of vegetation, using native species			x												
Install bird and bat boxes			x												
Minimise use of mown lawns on site			x										x		
Avoid development in areas of high carbon storage		x		x						x					

Suggested GI intervention	Risk of flooding	Risk of loss of carbon storage	Risk of loss of biodiversity	Risk of urban heat island effect	Risk of coastal storms	Risk of poor air quality	Risk of inadequate non-portable water supply	Risk of soil erosion	Risk to tourism growth	Risk of poor recreation resource	Risk of poor aesthetics	Risk of little green travel	Risk of noise	Risk of poor green infrastructure support for heritage resource	Risk of poor green infrastructure support for cultural resource
Design the green infrastructure to improve the image of the area, taking into account landscape character											x				
Provide public access to the on-site green infrastructure, including any linear features such as rivers and canals									x	x				x	
Provide benches on-site, in a variety of microclimates									x	x					x
Provide recreation facilities on site different age groups									x	x					x

Suggested GI intervention	Risk of flooding	Risk of loss of carbon storage	Risk of loss of biodiversity	Risk of urban heat island effect	Risk of coastal storms	Risk of poor air quality	Risk of inadequate non-portable water supply	Risk of soil erosion	Risk to tourism growth	Risk of poor recreation resource	Risk of poor aesthetics	Risk of little green travel	Risk of noise	Risk of poor green infrastructure support for heritage resource	Risk of poor green infrastructure support for cultural resource
Safeguard existing green infrastructure and landforms that act as sound and visual barriers										x	x		x		
Create new green infrastructure features as part of sound and visual barriers										x	x		x		
No development on best and most versatile agricultural land	x			x										x	
Safeguard any allotments on site										x					x
Create allotments on site		x	x	x						x					x
Use species that provide food, including fruit and nuts			x												

Suggested GI intervention	Risk of flooding	Risk of loss of carbon storage	Risk of loss of biodiversity	Risk of urban heat island effect	Risk of coastal storms	Risk of poor air quality	Risk of inadequate non-portable water supply	Risk of soil erosion	Risk to tourism growth	Risk of poor recreation resource	Risk of poor aesthetics	Risk of little green travel	Risk of noise	Risk of poor green infrastructure support for heritage resource	Risk of poor green infrastructure support for cultural resource
Compost household and garden waste for use on site		x													
Involve the local community in the design, construction and management of the site										x					x
All windows in office developments to have a view over greenery									x		x				
In office developments, provision of accessible outdoor green space for office workers										x	x	x			

Suggested GI intervention	Risk of flooding	Risk of loss of carbon storage	Risk of loss of biodiversity	Risk of urban heat island effect	Risk of coastal storms	Risk of poor air quality	Risk of inadequate non-portable water supply	Risk of soil erosion	Risk to tourism growth	Risk of poor recreation resource	Risk of poor aesthetics	Risk of little green travel	Risk of noise	Risk of poor green infrastructure support for heritage resource	Risk of poor green infrastructure support for cultural resource
Water-related interventions	x		x	x	x		x		x	x	x			x	x
Avoid development in river and coastal flood zones	x				x										
Use river and coastal flood zones as multifunctional green spaces, including combining recreation and biodiversity with flood water storage			x				x								x
De-culvert water courses			x												
Re-create natural floodplain vegetation	x		x					x						x	

Suggested GI intervention	Risk of flooding	Risk of loss of carbon storage	Risk of loss of biodiversity	Risk of urban heat island effect	Risk of coastal storms	Risk of poor air quality	Risk of inadequate non-portable water supply	Risk of soil erosion	Risk to tourism growth	Risk of poor recreation resource	Risk of poor aesthetics	Risk of little green travel	Risk of noise	Risk of poor green infrastructure support for heritage resource	Risk of poor green infrastructure support for cultural resource
Create or enhance green infrastructure upstream to store flood waters	x						x								
Use Sustainable Urban Drainage Systems (SUDS) as part of the on-site green infrastructure so there is no increase in runoff post-development and water quality is improved	x														
Use permeable surfacing within the design of any green infrastructure areas	x														

Suggested GI intervention	Risk of flooding	Risk of loss of carbon storage	Risk of loss of biodiversity	Risk of urban heat island effect	Risk of coastal storms	Risk of poor air quality	Risk of inadequate non-portable water supply	Risk of soil erosion	Risk to tourism growth	Risk of poor recreation resource	Risk of poor aesthetics	Risk of little green travel	Risk of noise	Risk of poor green infrastructure support for heritage resource	Risk of poor green infrastructure support for cultural resource
Where soils have a high water infiltration rate, keep surfaces unsealed	x														
Harvest, store and use rainwater on-site to irrigate green infrastructure (so that it provides urban cooling)							x								
Increase of blue cover and features on site for its role in urban cooling			x	x											

Suggested GI intervention	Risk of flooding	Risk of loss of carbon storage	Risk of loss of biodiversity	Risk of urban heat island effect	Risk of coastal storms	Risk of poor air quality	Risk of inadequate non-portable water supply	Risk of soil erosion	Risk to tourism growth	Risk of poor recreation resource	Risk of poor aesthetics	Risk of little green travel	Risk of noise	Risk of poor green infrastructure support for heritage resource	Risk of poor green infrastructure support for cultural resource
Irrigate green infrastructure on site, preferably from a sustainable source (e.g. greywater or harvested rainwater)	x		x												

Suggested GI intervention	Risk of flooding	Risk of loss of carbon storage	Risk of loss of biodiversity	Risk of urban heat island effect	Risk of coastal storms	Risk of poor air quality	Risk of inadequate non-portable water supply	Risk of soil erosion	Risk to tourism growth	Risk of poor recreation resource	Risk of poor aesthetics	Risk of little green travel	Risk of noise	Risk of poor green infrastructure support for heritage resource	Risk of poor green infrastructure support for cultural resource
Linear features and connectivity			x						x	x	x	x		x	
Use green infrastructure on site to connect up nearby habitats off site			x												
Make linear features such as canals, rivers, railway lines, and road verges friendly to wildlife			x											x	
Create new wildlife friendly linear features (e.g. hedgerows)			x												
Safeguard existing rights of way on the site									x	x		x			

Suggested GI intervention	Risk of flooding	Risk of loss of carbon storage	Risk of loss of biodiversity	Risk of urban heat island effect	Risk of coastal storms	Risk of poor air quality	Risk of inadequate non-portable water supply	Risk of soil erosion	Risk to tourism growth	Risk of poor recreation resource	Risk of poor aesthetics	Risk of little green travel	Risk of noise	Risk of poor green infrastructure support for heritage resource	Risk of poor green infrastructure support for cultural resource
Connect public access routes in on-site green infrastructure to existing access routes in the surrounding area (e.g. public rights of way)									x	x		x			
Provide sign-posting to connect up green infrastructure routes									x	x	x	x			

The following table shows how green infrastructure interventions relate to each of the Framework priorities.

Suggested GI intervention	Setting the Scene for Growth	Supporting Adaptation to Climate Change	Providing Recreation, Leisure and Tourism	Enhancing the Ecological Framework	Developing the Rural Economy	Supporting Health and Well-being
Increase tree cover on site	x	x	x	x	x	x
Select a mixture of native species (to provide food and habitat for wildlife)				x		
Select species to improve air quality						x
Select species to provide shade (e.g. that will have large canopies when mature) and plant in areas where people walk and gather		x	x			x
Select broadleaf species and plant to provide shade to buildings (e.g. on south facing facades)		x				
Select species with large canopies to capture rainwater		x				
Select species (e.g. conifers) and plant to provide wind shelter		x	x			
Select species and plant for aesthetic quality / image and to provide visual screening	X		x		x	
Select species to provide fruit and nuts				x	x	

Suggested GI intervention	Setting the Scene for Growth	Supporting Adaptation to Climate Change	Providing Recreation, Leisure and Tourism	Enhancing the Ecological Framework	Developing the Rural Economy	Supporting Health and Well-being
Planted in streets	X	x		x		
Retain existing mature trees on site			x		x	
Planted along streams, rivers and on floodplains		x				
Select and manage species to provide carbon sequestration and storage		x				
Plant trees to stabilise slopes and soils vulnerable to erosion		x				
Plant trees as part of a sound barrier			x			x
Manage trees on site as a timber and/or fuel resource					x	

Suggested GI intervention	Setting the Scene for Growth	Supporting Adaptation to Climate Change	Providing Recreation, Leisure and Tourism	Enhancing the Ecological Framework	Developing the Rural Economy	Supporting Health and Well-being
Install green roofs	x	x	x	x	x	x
Designed to capture rainwater		x				
Design green roofs to increase biodiversity (e.g. using a variety of substrates, differing depths, and selecting species appropriately)					x	
Design green roofs to allow access by people			x			x
Grow food crops					x	
Install on buildings which are overlooked for aesthetic purposes						x

Suggested GI intervention	Setting the Scene for Growth	Supporting Adaptation to Climate Change	Providing Recreation, Leisure and Tourism	Enhancing the Ecological Framework	Developing the Rural Economy	Supporting Health and Well-being
Install green walls	x	x		x	x	x
Plant to provide shade to buildings (e.g. on south facing facades); reducing direct solar gain in summer, use species to allow for solar gain in winter		x			x	x
Plant to increase biodiversity (e.g. species to provide food and habitat)				x		
Grow food crops					x	
Plant to improve aesthetic quality or image	x				x	

Suggested GI intervention	Setting the Scene for Growth	Supporting Adaptation to Climate Change	Providing Recreation, Leisure and Tourism	Enhancing the Ecological Framework	Developing the Rural Economy	Supporting Health and Well-being
General vegetation-related interventions	x	x	x	x	x	x
Increase green cover on site		x				
Design green infrastructure on site to provide a variety of micro-climates for users (e.g. access to sun, shade, wind, shelter)		x	x			x
Plant vegetation to stabilise slopes and soils vulnerable to erosion		x				
Safeguard wildlife habitats on site, referring to Biodiversity Action Plans				x		
Create new habitats on site, including ponds				x		
Select vegetation to provide food for wildlife e.g. nectar rich plants				X		
Plant a diverse mixture of vegetation, using native species				x		
Install bird and bat boxes				x		
Minimise use of mown lawns on site		x		x		
Avoid development in areas of high carbon storage		x				

Suggested GI intervention	Setting the Scene for Growth	Supporting Adaptation to Climate Change	Providing Recreation, Leisure and Tourism	Enhancing the Ecological Framework	Developing the Rural Economy	Supporting Health and Well-being
Design the green infrastructure to improve the image of the area, taking into account landscape character	x		x		x	
Provide public access to the on-site green infrastructure, including any linear features such as rivers and canals			x			x
Provide benches on-site, in a variety of microclimates		x	x			x
Provide recreation facilities on site different age groups			x			x
Safeguard existing green infrastructure and landforms that act as sound and visual barriers	x				x	
Create new green infrastructure features as part of sound and visual barriers	x				x	
No development on best and most versatile agricultural land					x	
Safeguard any allotments on site					x	
Create allotments on site					x	

Suggested GI intervention	Setting the Scene for Growth	Supporting Adaptation to Climate Change	Providing Recreation, Leisure and Tourism	Enhancing the Ecological Framework	Developing the Rural Economy	Supporting Health and Well-being
Use species that provide food, including fruit and nuts					x	
Compost household and garden waste for use on site					x	
Involve the local community in the design, construction and management of the site			x			x
All windows in office developments to have a view over greenery	x					
In office developments, provision of accessible outdoor green space for office workers	x					

Suggested GI intervention	Setting the Scene for Growth	Supporting Adaptation to Climate Change	Providing Recreation, Leisure and Tourism	Enhancing the Ecological Framework	Developing the Rural Economy	Supporting Health and Well-being
Water-related interventions		x	x	x	x	x
Avoid development in river and coastal flood zones					x	
Use river and coastal flood zones as multifunctional green spaces, including combining recreation and biodiversity with flood water storage			x	x		x
De-culvert water courses				x		
Re-create natural floodplain vegetation		x				
Create or enhance green infrastructure upstream to store flood waters		x				
Use Sustainable Urban Drainage Systems (SUDS) as part of the on-site green infrastructure so there is no increase in runoff post-development and water quality is improved		x				
Use permeable surfacing within the design of any green infrastructure areas		x				

Suggested GI intervention	Setting the Scene for Growth	Supporting Adaptation to Climate Change	Providing Recreation, Leisure and Tourism	Enhancing the Ecological Framework	Developing the Rural Economy	Supporting Health and Well-being
Where soils have a high water infiltration rate, keep surfaces unsealed		x				
Harvest, store and use rainwater on-site to irrigate green infrastructure (so that it provides urban cooling)		x				
Increase of blue cover and features on site for its role in urban cooling		x	x			x
Irrigate green infrastructure on site, preferably from a sustainable source (e.g. greywater or harvested rainwater)		x				

Suggested GI intervention	Setting the Scene for Growth	Supporting Adaptation to Climate Change	Providing Recreation, Leisure and Tourism	Enhancing the Ecological Framework	Developing the Rural Economy	Supporting Health and Well-being
Linear features and connectivity			x	x	x	x
Use green infrastructure on site to connect up nearby habitats off site				x		
Make linear features such as canals, rivers, railway lines, and road verges friendly to wildlife				x		
Create new wildlife friendly linear features (e.g. hedgerows)				x		
Safeguard existing rights of way on the site			x			x
Connect public access routes in on-site green infrastructure to existing access routes in the surrounding area (e.g. public rights of way)	x		x			x
Provide sign-posting to connect up green infrastructure routes	x		x			x