Natural Capital Solutions

Natural capital assessment for Liverpool Waters

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Executive summary

This report presents the results of a natural capital, ecosystem services assessment and valuation for Liverpool Waters, a major development on the east bank of the River Mersey in the centre of Liverpool. The 1,691,100 square metre business and residential development over five neighbourhoods has begun on 60 hectares of reclaimed and former dock land. Due to the size of the development it has been phased over a 30-year construction period, which commenced in 2012 and is due to be complete in 2041.

Natural capital is the stock of natural assets (e.g. soils, water, biodiversity) that produces a wide range of ecosystem services that provide benefits to people. These benefits include food production, regulation of flooding, air quality and climate, and cultural benefits such as recreational and physical health opportunities. The principles of natural capital and ecosystem services are central to the UK Government's 25-year Environment Plan, from which biodiversity net gain is to become mandatory, and environmental net gain to follow in the future. This concept has also been adopted by the Liverpool City Region, for which a recent natural capital and ecosystem services baseline assessment has been completed. This assessment provides the evidence base for engagement with funds created through natural capital policies, and to develop strategies around air pollution reduction, meeting the Carbon Neutral City target by 2040, and generally enhancing economic and social well-being in the region.

The aim of this project was to model the ecosystem services, value the benefits, and assess biodiversity of Liverpool Waters baseline and masterplan, to see if natural capital and biodiversity net gain could be achieved. Natural capital was mapped across the site under the baseline (pre-development) condition and under the most up to date masterplan. The capacity of the natural environment to deliver 8 different ecosystem services was then modelled and mapped at high resolution across the site (carbon storage, carbon sequestration, air quality regulation, climate regulation, noise regulation, water flow, water quality, and accessible nature). The demand for air quality regulation, noise regulation, and climate regulation services was also mapped. A further 4 services were quantified but not mapped (timber production, water recreation, physical health and well-being). All of these, including carbon sequestration, and air quality regulation were assigned a monetary value.

The site prior to development (the baseline) consisted largely of sealed surfaces and water in the form of docks. The habitats that existed were those associated with derelict sites, for example shrub, short perennial and ruderal vegetation growing on sealed surfaces. This resulted in a low provision of benefits, particularly carbon storage and sequestration, air quality regulation, noise regulation, with no provision for cultural services such as access to recreation, physical health and well-being. Consequently, carbon sequestration, timber production, air pollution regulation, physical health and well-being had little or no monetary value. The provision of the water recreation did have value (present value £1.2 million over 50 years). The provision of local climate regulation, water flow and quality was reasonable at the site. The demand maps for local climate regulation, noise regulation and air pollution regulation all demonstrated a high demand for these services in the 1.5 km^2 area of Liverpool city centre around Liverpool Waters. The biodiversity assessment showed a relatively low baseline quality of 16.45 biodiversity units.

Under the proposed masterplan, where there has been an increase in the quality of habitats incorporated into the site (woodland, street trees, perennials), and provision of green space in the form of a public park for access to recreational opportunities, 8 out of the 12 ecosystem services assessed increased. These are carbon storage and sequestration, timber production, air quality regulation, water quality, access to nature, physical health and well-being. The water recreation service did not change from baseline to masterplan, while local climate regulation, noise regulation and water flow decreased slightly. Carbon sequestration increased by 5 tonnes/CO_2e/yr, and therefore by £20,000 in present value over 50-years, the regulation of $PM_{2.5}$ increased by 0.03 tonnes/yr, with an increase of £375,000 in the present value over 50 years. By far the most valuable services are physical health and wellbeing, due to the provision of green space, increasing the present value from 0 to £169.2 million and £1.1 billion over 50 years, respectively. Taken together, the Liverpool Waters development delivers an additional £34.4 million of public benefits annually, with a present value of £1.3 billion over 50 years compared to the baseline. Unfortunately, the masterplan does not achieve biodiversity net gain at the site in its current design (9.52 biodiversity units for the masterplan, a change of -6.93). It is not far from no net loss if the Central Docks neighbourhood is taken in isolation.

The Liverpool Waters development will achieve net gain in ecosystem services provision, and this is just for the ecosystem services that could be quantified. Recreation is a significant and very valuable service that we did not have the data to estimate reliably in the project. So the overall additional value of the development is likely to be higher. There were also three ecosystem services that decreased slightly, and it may be that this is in part due to the ecosystem service models assuming that the baseline habitats were of better quality than they were (e.g. assuming soil where there is none), and therefore inflating the baseline scores. Biodiversity net gain could not be achieved in this development, and this may not even be possible if more green space and higher quality habitats were incorporated into the current design. The biodiversity net gain agenda aims to reduce the loss of quality habitat, and the tool is intended for use across all types of development, but does not deal with urban habitats well. Therefore, the approach and tool isn't fully suited for use at such an urban site. It is possible that due to the inability of the tool to correctly characterise the poor quality of the baseline, that it has made biodiversity net gain harder to achieve here.

We recommend that adding more trees to the design will increase the carbon sequestration, air quality regulation, noise regulation, well-being, water flow and quality regulation of the development. These are important services in urban developments near roads, for alleviating urban run-off and creating opportunities to enhance the health and well-being of residents and workers. Areas that would ordinarily be amenity grassland would benefit from management for more structure and diversity, for instance wildflower meadows in the park or in other public spaces. This would increase water flow, quality and biodiversity units. Overall more green space provision could be designed into the Liverpool Waters development, with a focus on linking up similar habitats. However, it may be more beneficial to think strategically about how the biodiversity units can be off-set in the wider Liverpool city area, in line with the Liverpool City Region's upcoming strategies for achieving a Carbon Neutral City, reduction in air pollution and nature recovery networks

Contents

1. Introduction

The concepts of natural capital and ecosystem services are being increasingly recognised by the public and private sectors. They are backed by a number of local, national and international policies, which are encouraging more joined-up and sustainable decision making and planning. Adopting the natural capital and ecosystem services approach is a key policy objective of the UK Government (and worldwide) and central to its 25-year Environment Plan. Attaining biodiversity net gain in development is to become mandatory in 2020, and there is an intention to operationalise the concept of environmental net gain in the future (although what exactly this means is yet to be defined). Meanwhile, the National Planning Policy Framework places sustainable development at the heart of England's planning policy, which requires a careful balance between social, economic and environmental considerations. The evaluation of natural capital and ecosystem services provides an appropriate framework to inform these requirements.

At a local level, the concept of ecosystem services is starting to be incorporated into the thinking and strategy of the Liverpool City Region (LCR). LCR commissioned an assessment of the natural capital and ecosystem services baseline for the region. The aim is to use this evidence base to engage with and benefit from opportunity for funds created by natural capital policies (e.g. biodiversity and environmental net gain, the new Environmental Land Management Scheme) and other private funds which may become available (e.g. private investment for return in the Greater Manchester Combined Authority Natural Capital Investment Plan), and to enhance the economic and social well-being of the LCR. It is also important in the context of the climate emergency and the vision for Liverpool to be a Carbon Neutral City by 2040.

An assessment of natural capital and ecosystem services (ES) can be extremely informative at guiding planning and development, but as yet there are few examples of the practical application of such an approach in the planning and development sector. The application of this approach at the Liverpool Waters site will, therefore, be novel.

The Liverpool Waters development is on the east bank of the River Mersey, in the centre of the Liverpool (Map 1). It is 60 hectares of reclaimed land created from the docks. Over one third of the site comprises docks with open water. The site is, therefore, valued for its heritage, and some of these features remain, for example the original dock wall and the Jesse Hartley Victoria Clock Tower. Some of the site falls within the Liverpool World Heritage Site designation. The site is also adjacent to the Mersey Estuary which has national and international designations for its habitats and fauna of conservation importance (SSSI, SPA and Ramsar).

The development itself is a 1,691,100 square metre business and residential development divided into five neighbourhoods: Princes Dock, King Edward Triangle, Central Docks, Clarence Docks and Northern Docks (Map 1). Due to its size the development has been based on a 30-year construction process, which commenced in 2012 and will be complete in 2041. Due to this timescale the project has not yet been designed in full.

The overall aim of this project was to carry out a natural capital and ecosystem services (including biodiversity) assessment and valuation of the proposed development, comparing the situation before and after construction, to determine the potential impact. The baseline for the project was 2006 pre the construction of the Liverpool canal link. The development scenario was the existing design to date, that is Princes Dock, Central Dock and a basic plan of the other neighbourhoods.

Map 1. Liverpool Waters, its neighbourhoods and location in Liverpool city (source: PLANIT-IE (2019)).

The natural capital and ecosystem services framework

The natural environment underpins our wellbeing and economic prosperity, providing multiple benefits to society, yet is consistently undervalued in decision-making. Natural Capital is defined as "..*elements of nature that directly or indirectly produce value to people, including ecosystems, species, freshwater, land, minerals, the air and oceans*" (Natural Capital Committee 2014). It is the stock of natural assets (e.g. soils, water, biodiversity) that produces a wide range of ecosystem services that provide benefits to people. These benefits include food production, regulation of flooding and climate, pollination of crops, and cultural benefits such as aesthetic value and recreational opportunities (Figure 1).

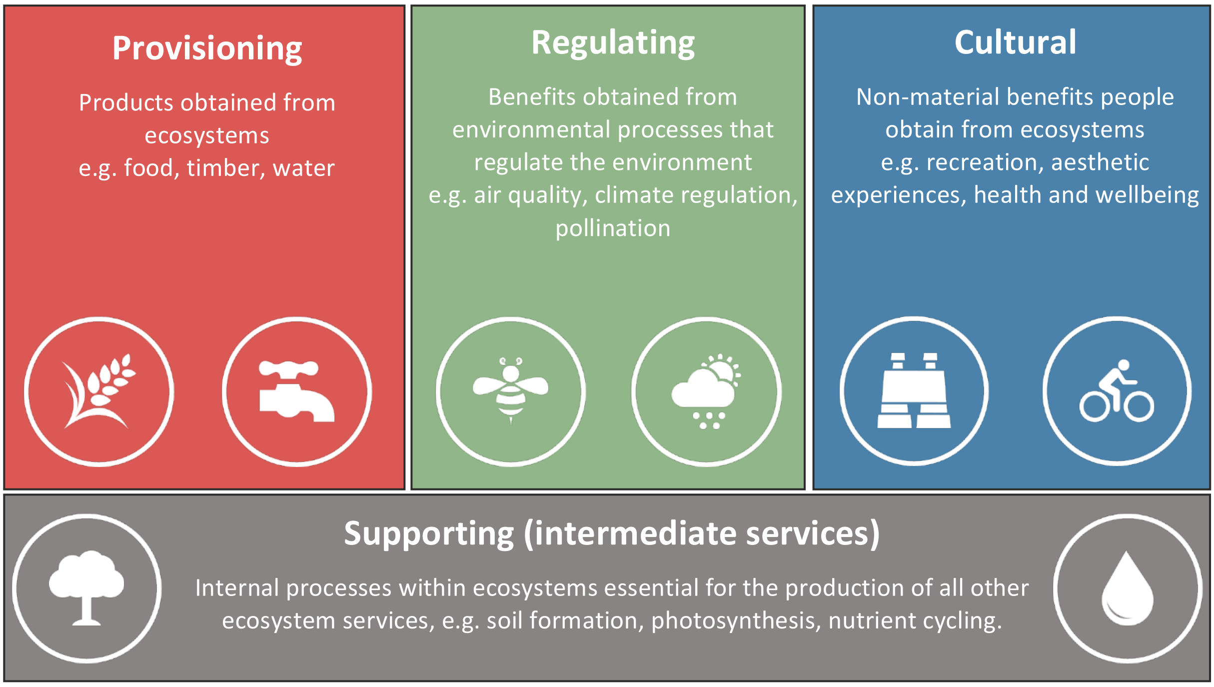


Figure 1: Key types of ecosystem services (based on MA 2005)

Much work is progressing on how to deliver the natural capital and ecosystem services approach on the ground and how to use it to inform and influence management and decision-making. One of the most important steps is to recognise and quantify ecosystem service delivery (the physical flow of services derived from natural capital). It is also possible to examine how this will change following development, and hence determine the potential impact of the proposal. Additional insight can be gained by taking a spatial perspective on the variation in ecosystem service supply and demand across a study area using a Geographic Information System (GIS). Maps are able to highlight hotspots and coldspots of ecosystem service delivery, highlight important spatial patterns that provide much additional detail, and are inherently more user friendly than non-spatial approaches.

1.1 The approach

This project aims to:

- Map the natural capital for Liverpool Waters baseline and masterplan.
- Map the capacity of the site to provide a suite of ecosystem services, including the demand for a subset of these services, for the baseline and the masterplan.
- Estimate the monetary value of the ecosystem services (including cultural services that it is not possible to map at this scale).
- Complete a biodiversity net gain assessment for the development.
- Compare the results for the baseline and masterplan to understand the impact of the development, and to assess whether it achieves biodiversity and natural capital net gain.

We use a spatial mapping and modelling approach to assess the natural capital and ecosystem services of Liverpool Waters baseline and masterplan. We use EcoServ-GIS (a toolkit developed by the Wildlife Trusts, with a number of bespoke modifications) and a number of independent models to quantify the capacity of the site to provide ecosystem services. For the valuation, annual physical and monetary flows were calculated for a subset of the ecosystem services mapped in 2019 prices. It is still not possible to satisfactorily value all ecosystem services, especially water quality and flow regulation. Hydrological modelling is required for these services, and it is more difficult to asses them at a small scale, than at a landscape scale. The annual values were also presented as present values of future flows from the natural capital assets estimated over a 50-year period using discount rates from the HM Treasury (2019). The biodiversity net gain was assessed using the beta version of the Biodiversity Metric 2.

We present the results of the analyses in the main body of the report, and the methodology used is outlined in more detail in the Technical Appendix at the end of the report (Sections A, B & C).

2. Baseline and masterplan natural capital basemap and asset register

2.1 Liverpool Waters

As described above, the Liverpool Waters development is a long-term development on 60 hectares of reclaimed dock land at the heart of the city of Liverpool. It will provide 1,691,100 square metres of business and residential development within five neighbourhoods: Princes Dock, King Edward Triangle, Central Docks, Clarence Docks and Northern Docks. Part of the site falls within Liverpool's World Heritage Site designation, and there are also a number of sensitive habitats surrounding the site that have national and European level conservation designations mainly for the water bird populations. Although the baseline site lacks green space, it is important for recreation as the publicly accessible waterfront promenade runs along the edge of the site with views across the River Mersey. It also hosts the Friends of Allonby Canoe Club.

For the masterplan scenario we use detailed plans for Princes Dock, which is now being developed, and the Central Docks, which is the next neighbourhood from the development in the masterplanning process. A detailed neighbourhood plan has been developed for this the

Central Docks. These two neighbourhoods comprise a mix of business and residential plots, some with river views. There are green space provisions in the form of a public park and gardens designed in, most notably the central park, including grassland and woodland. It has been planned to maximise visual and physical connections with nature, so the design includes planting, wildlife habitats and Sustainable Drainage Systems (SuDS) to capture rainfall. The aim of this is to connect the residents and visitors to nature and to increase health and well-being. The site will provide a link between North Liverpool and the city centre, providing a range of recreational activities, cultural events and celebrations that will increase the connection with nature, and some will depend on the natural capital assets of the site. The site design will encourage walking and cycling over car use, with path and cycleways that connect residents to the city centre.

2.2 Creating a habitat baseline map

Before the flow or value of ecosystem services can be calculated and mapped, it is necessary to obtain an accurate assessment of the natural capital assets in the baseline study area and how these will change under the planned development masterplan. The most important component of this was to create a habitat basemap for the current situation and a comparable map for the proposed masterplan.

The habitat basemap was created using EcoServ-GIS. This approach uses MasterMap polygons as the underlying mapping unit and then uses a series of different data sets to classify each polygon to a detailed habitat type, and to associate a range of additional data with each polygon.

The Liverpool Waters area has been the subject of a number of surveys as part of the planning process, which were used to verify and improve the accuracy of the basemap, in particular, the Phase 1 habitat survey of the area produced by WYG in 2009. Therefore, the basemap was extensively checked and altered to incorporate this more detailed data.

A site such as Liverpool Waters will be impacted by, and have impacts on, a much wider area than simply the site boundary. People are expected to travel to the nearby city centre, and *vice versa*, people from the city centre will travel to Liverpool Waters to use the accessible green spaces and other facilities. For Liverpool Waters, the city of Liverpool is likely to influence ecosystem service flows, especially demands for ecosystem services. Therefore, the basemap was created for the site and a 1.5 km buffer, and all ecosystem services were mapped for across this larger area. We present the ecosystem service maps for the site only, as we are only interested in the capacity of this site to provide benefits, but we present the demand maps with the wider buffer area because demand will be largely from outside the site, particularly for the baseline condition.

2.3 Baseline habitats and quality

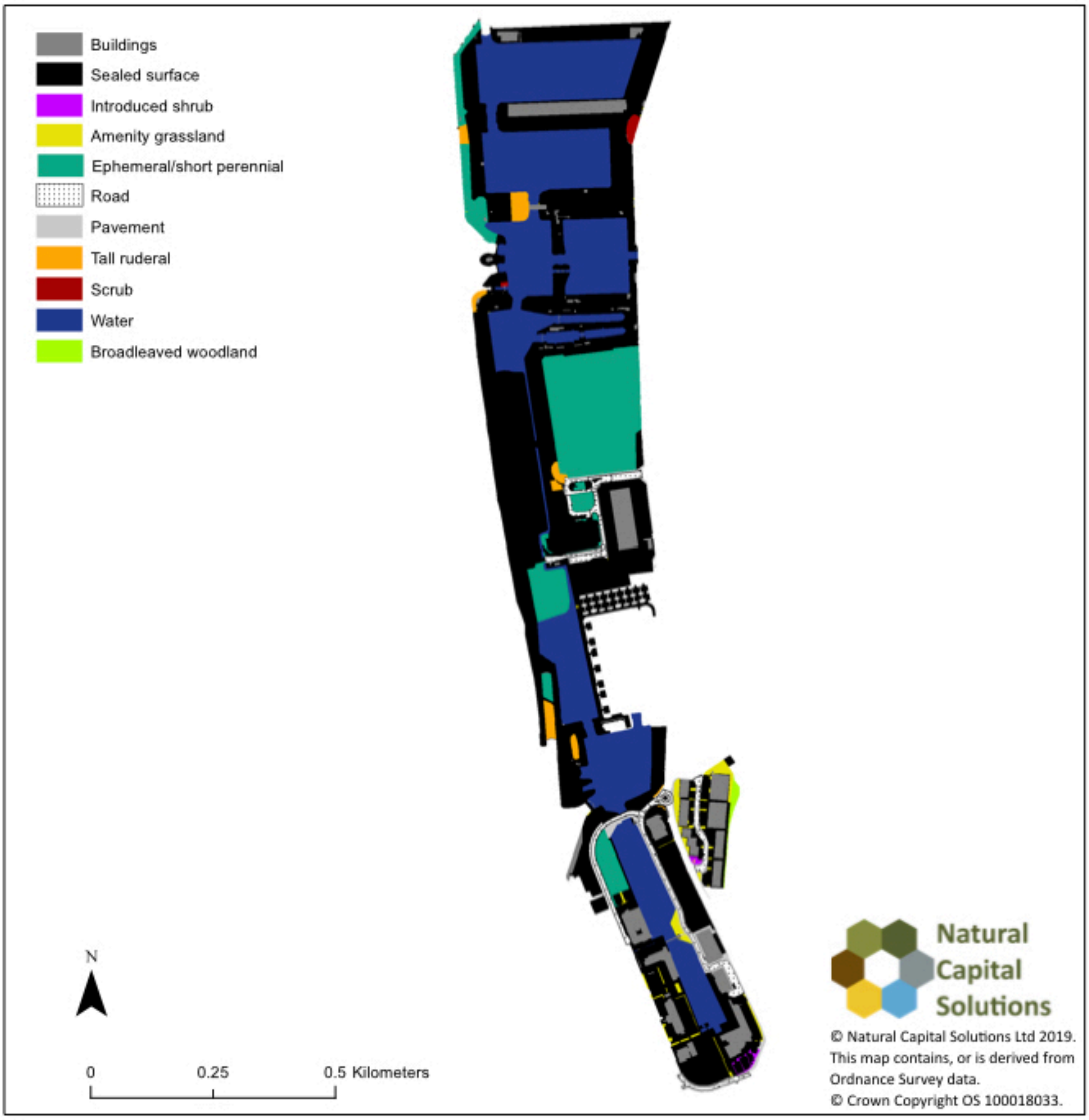
A map showing the key habitats within the Liverpool Waters boundary area under the baseline (2006) situation is shown on the next page (Map 2), and the area of each broad habitat type is shown in Table 1. The Liverpool Waters boundary area is ~60 ha in size and the baseline situation was dominated by buildings, sealed surfaces and water. There are small patches of short perennial, amenity grassland, scrub, introduced shrub, and tall ruderal vegetation. Whilst these areas have been surveyed and recorded as vegetated, it is important to understand that the patches of short perennial, scrub and tall ruderal species are effectively growing through concrete, the surfaces are sealed but vegetation has grown through during the period of time the site was purchased to the time when development has begun. These are habitats of very low quality.

Table 1. Area and percentage cover of broad habitat types under the baseline and proposed masterplan for Liverpool Waters.

Broad habitat type	Baseline		Masterplan		Change
	Area (ha)	**% cover**	**Area (ha)**	**% cover**	**Area (ha)**
Bare ground	0	0	0.05	0.1	+0.05
Buildings and sealed surfaces	30.63	52.8	36.71	61.7	+6.08
Tall ruderal	0.64	1.1	0	0	-0.64
Short perennial	6.9	11.9	0	0	-6.9
Introduced shrub	0.06	0.1	0.22	0.4	+0.16
Amenity grassland	0.58	1.0	0.88	1.5	+0.3
Gardens	0	0	2.30	3.9	+2.3
Urban park	0	0	0.18	0.3	+0.18
Scrub	0.12	0.2	0	0	-0.12
Scattered trees - broadleaved	0	0	0.71	1.2	+0.71
Scattered trees - coniferous	0	0	0.14	0.2	+0.14
Brackish water	19.14	33.0	18.29	30.8	-1.11

None of the land within the Liverpool Waters boundary area is subject to any nature conservation designations.

Map 2. Liverpool Waters baseline natural capital map



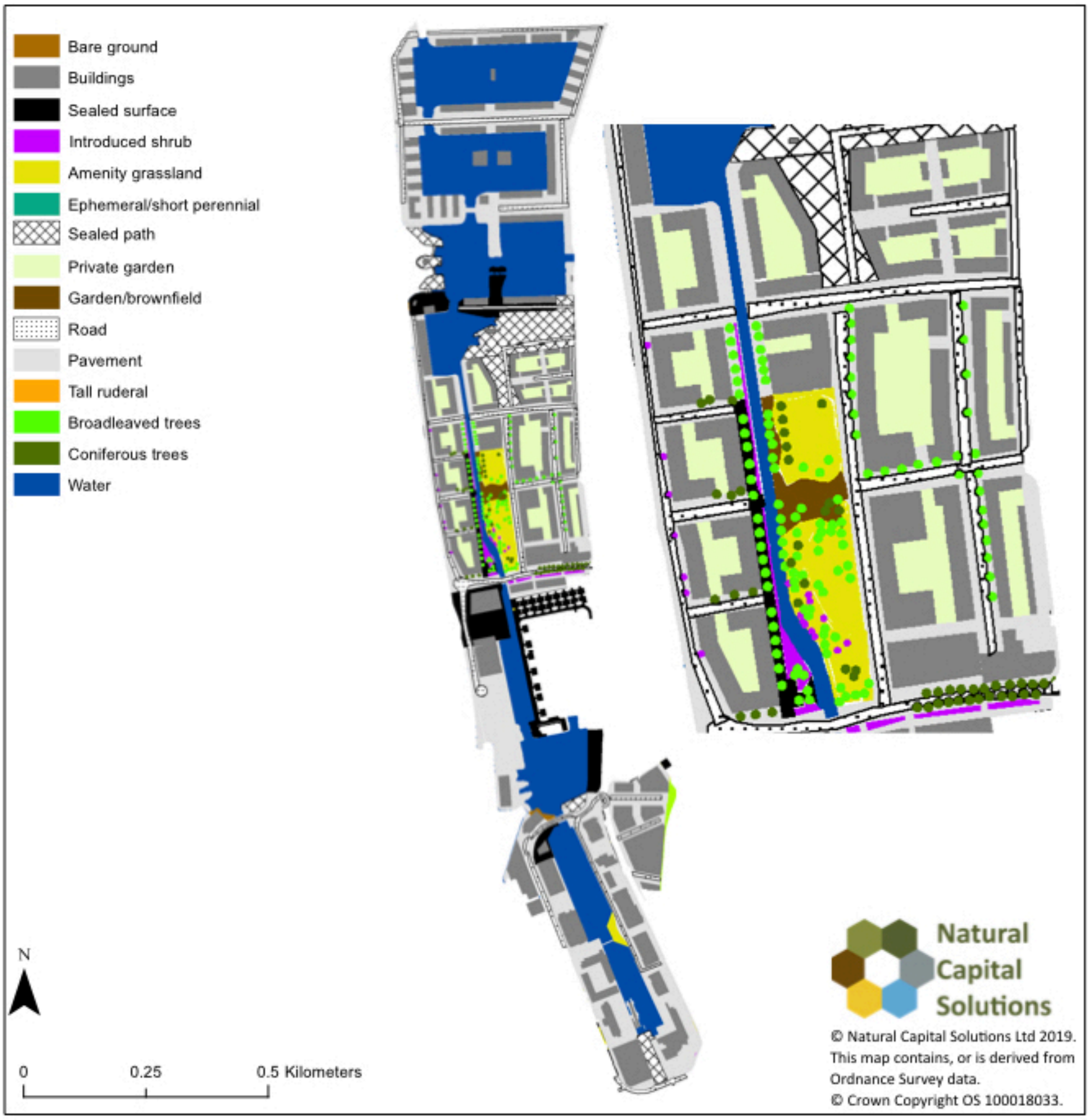
2.4 Creating a masterplan map

To analyse the flow of ecosystem services after the planned development it was important to create a map of the habitats under the proposed masterplan in exactly the same format as the basemap. The Liverpool Waters design team had created an outline masterplan in CAD format and this was georeferenced in GIS. There was a neighbourhood masterplan for Princes Dock and Central Docks. So the most detail on the green infrastructure within the site was within Central Docks. Information in this document that was not included in the masterplan layer (e.g. type and position of street trees) was added to the masterplan GIS. Creating a fully compatible GIS version of the masterplan was one of the most time-consuming parts of the assessment process. The buffer around the masterplan was the same as in the baseline basemap, so we can estimate the size of the changes in ecosystem service provision that is as a direct result of the changes made as part of the Liverpool Waters development.

2.5 Masterplan habitats

Map 3 shows the key habitats projected under the proposed masterplan, and the area of each broad habitat type is shown in Table 1 above, along with the change in area compared to the baseline. There is an increase in the area of buildings and sealed surfaces at the site from the baseline to masterplan of 6 hectares. The natural capital assets of the site have increased in quality, although the overall area of natural capital assets at the site has halved. There has been deliberate landscaping to include shrub, park and other green spaces consisting of amenity grassland, the urban park in the Central Docks area includes woodland, and there are a number of street trees included in the design. The residential areas also have shared gardens that will be green rather than sealed surface.

Map 3. Liverpool Waters masterplan natural capital map, with zoom in of the Central Dock area.



3. Baseline and masterplan ecosystem service mapping

Once a detailed habitat basemap had been created for both the baseline and masterplan, it was then possible to quantify and map the benefits that these habitats (natural capital) provide to people. The following benefits (ecosystem services) were mapped:

- Carbon storage
- Carbon sequestration
- Air quality regulation and demand
- Local climate regulation and demand
- Noise regulation and demand
- Water flow
- Water quality
- Accessible nature

The list of services assessed was considered to capture all of the most important services provided by the natural environment of the Liverpool Waters site. A variety of methods were used, and these are described for each individual ecosystem service in the sections below. In all cases the models were applied at a 10m by 10m resolution to provide fine scale mapping across the area. The models are based on the detailed habitat information determined in the basemaps, together with a variety of other external data sets (e.g. digital terrain model, UK census data 2011, open space data, and many other data sets and models mentioned in the methods for each ecosystem service). Note, however, that many of the models are indicative (showing that certain areas have higher capacity or demand than other areas) and are not process-based mathematical models (e.g. hydrological models). In all cases the capacity and demand for ES is mapped relative to the values present within the study area.

For every ecosystem service listed, the capacity of the natural environment to deliver that service – or the current supply – was mapped. For air pollution regulation, noise regulation, and local climate regulation, it was also possible to map the local demand (the beneficiaries) for these services. We only present the demand for the baseline, as this changes very little in the masterplan scenario. The importance and value of ecosystem services can often be dependent upon its location in relation to the demand for that service, hence capturing this information provides useful additional insight.

3.1 Assessing ecosystem services under the proposed masterplan

For the purposes of this assessment the masterplan for Liverpool Waters included what had been developed (Princes Dock), what was at the detailed neighbourhood plan stage (Central Docks), and a basic plan for the other neighbourhood areas. Evaluating the flow of ES under the proposed masterplan required certain additional information to be estimated, in addition to the masterplan habitat map. Key datasets amended, and the underlying assumptions are listed here:

- *Population data* – The Liverpool Waters will consist of 9000 new houses. Household occupancy (2.03 people per house) and age structure of the population, was estimated based on average figures for the whole of Liverpool, taken from the UK Census 2011.
- *Index of Multiple Deprivation (IMD)* – as above, IMD scores were estimated for Liverpool Waters by calculating and applying the average scores across all IMD categories for Liverpool as a whole.

- *Green infrastructure* – all green spaces around Liverpool Waters, were identified as publicly accessible or not.
- *Public Rights of Way and core paths* – new paths created as part of the development were added to this dataset.

3.2 Carbon storage capacity

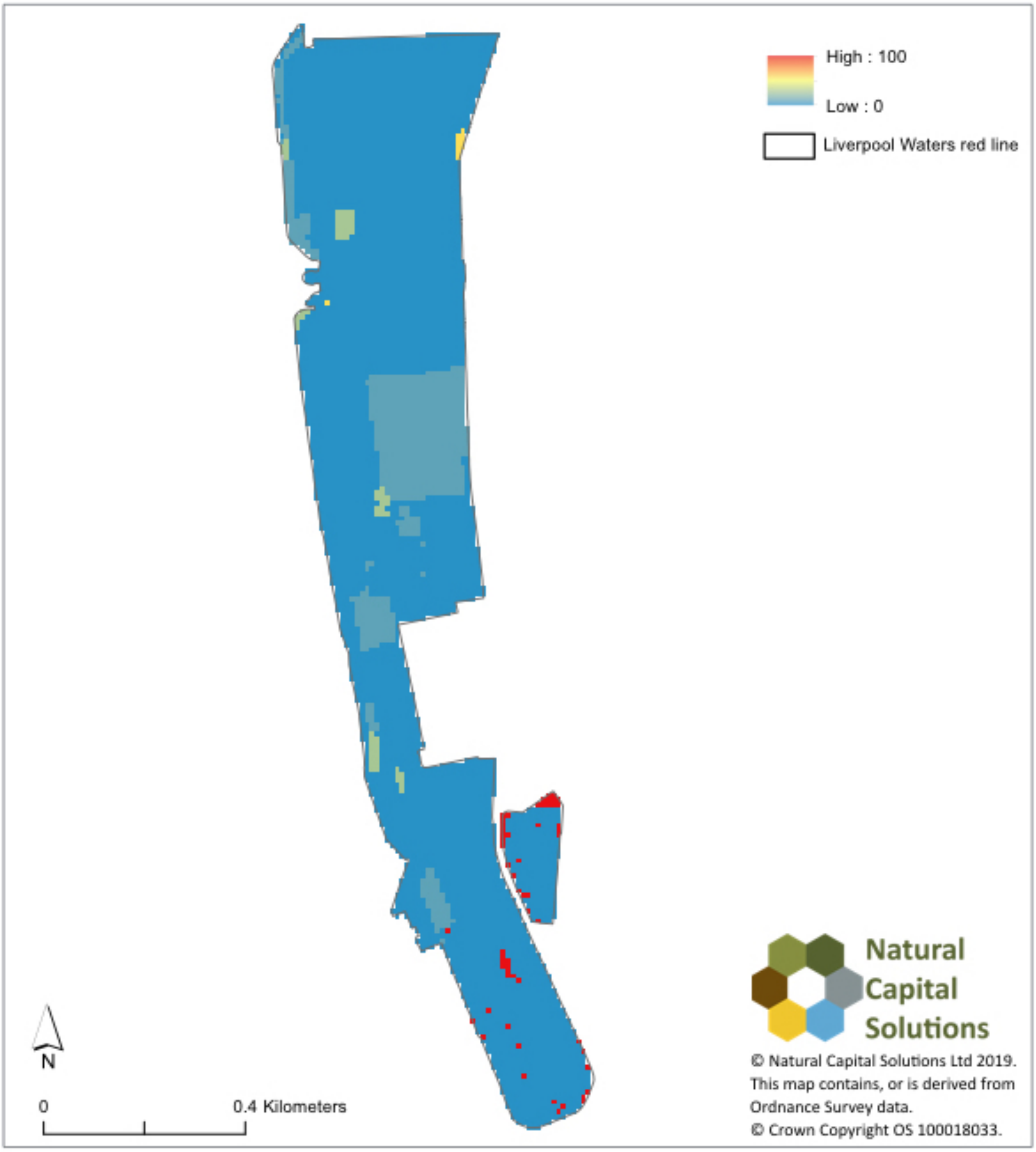
What is it and why is it important?
Carbon storage capacity indicates the amount of carbon stored naturally in soil and vegetation. Carbon storage and sequestration is seen as increasingly important as we move towards a low-carbon future. The importance of managing land as a carbon store has been recognised by the UK government, and land use has a major role to play in national carbon accounting. Changing land use from one type to another can lead to major changes in carbon storage, as can restoration of degraded habitats.

Results
Maps 4 and 5 show carbon storage across the study area for the baseline and masterplan respectively. The predominant carbon store in the baseline is the small area of woodland in the King Edward Triangle, and patches of amenity grassland in the Princes Dock area. The other habitats do not store much carbon at all. However, the carbon storage capacity increases in the masterplan, where much of the storage is in and around the central park area, the street trees and the residential gardens of the Central Docks neighbourhood. The areas of amenity grassland in the Princes Dock and King Edward Triangle area remain.

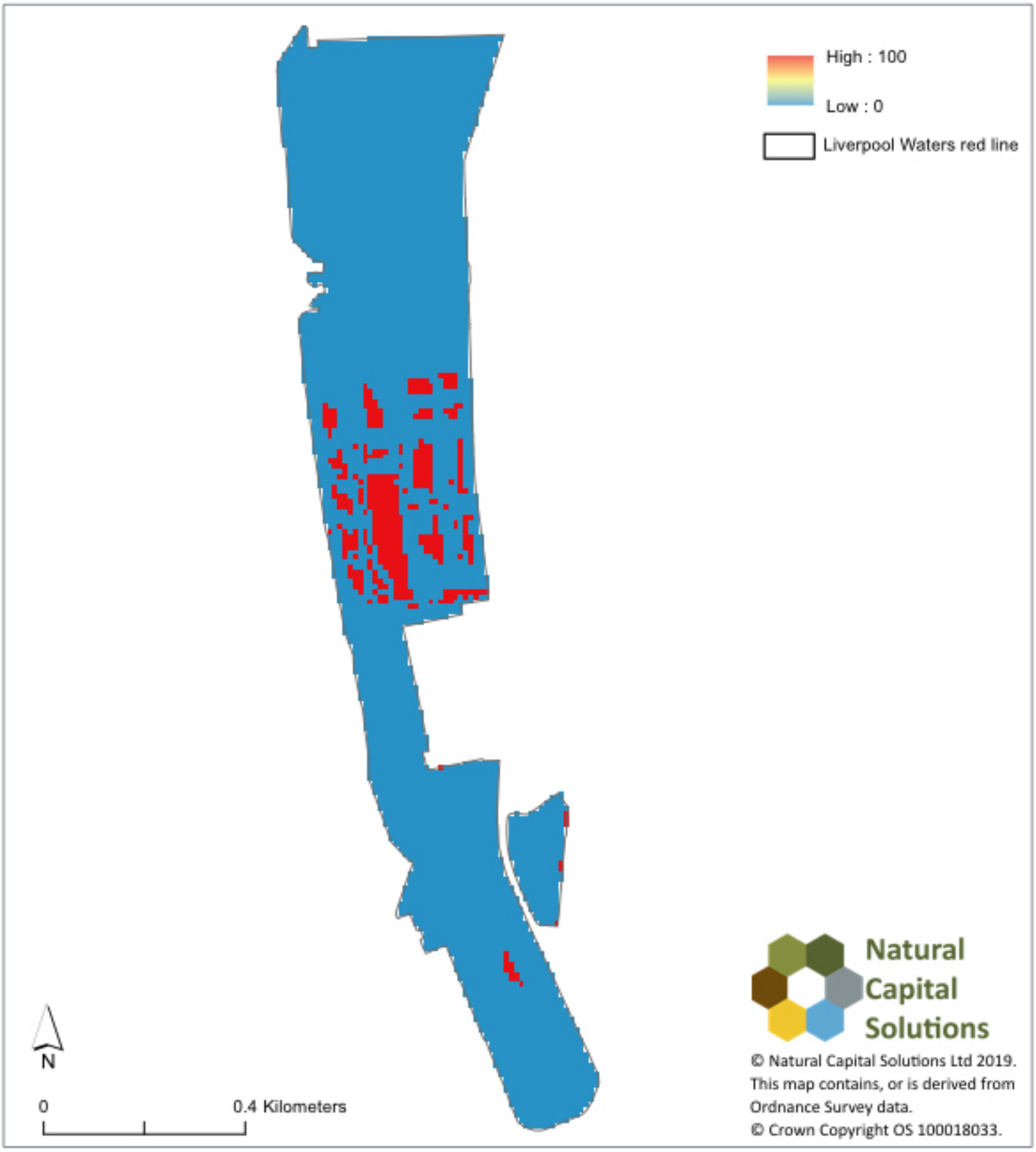
The scores below show the average carbon storage capacity for the Liverpool Waters red line area. The score is out of a maximum possible of 100 (in this case, if the whole area was covered in woodland).

Baseline score = 0.5 **Masterplan score = 2.76** **Change = +2.26**

Map 4. Carbon storage Liverpool Waters baseline.



Map 5. Carbon storage Liverpool Waters masterplan.

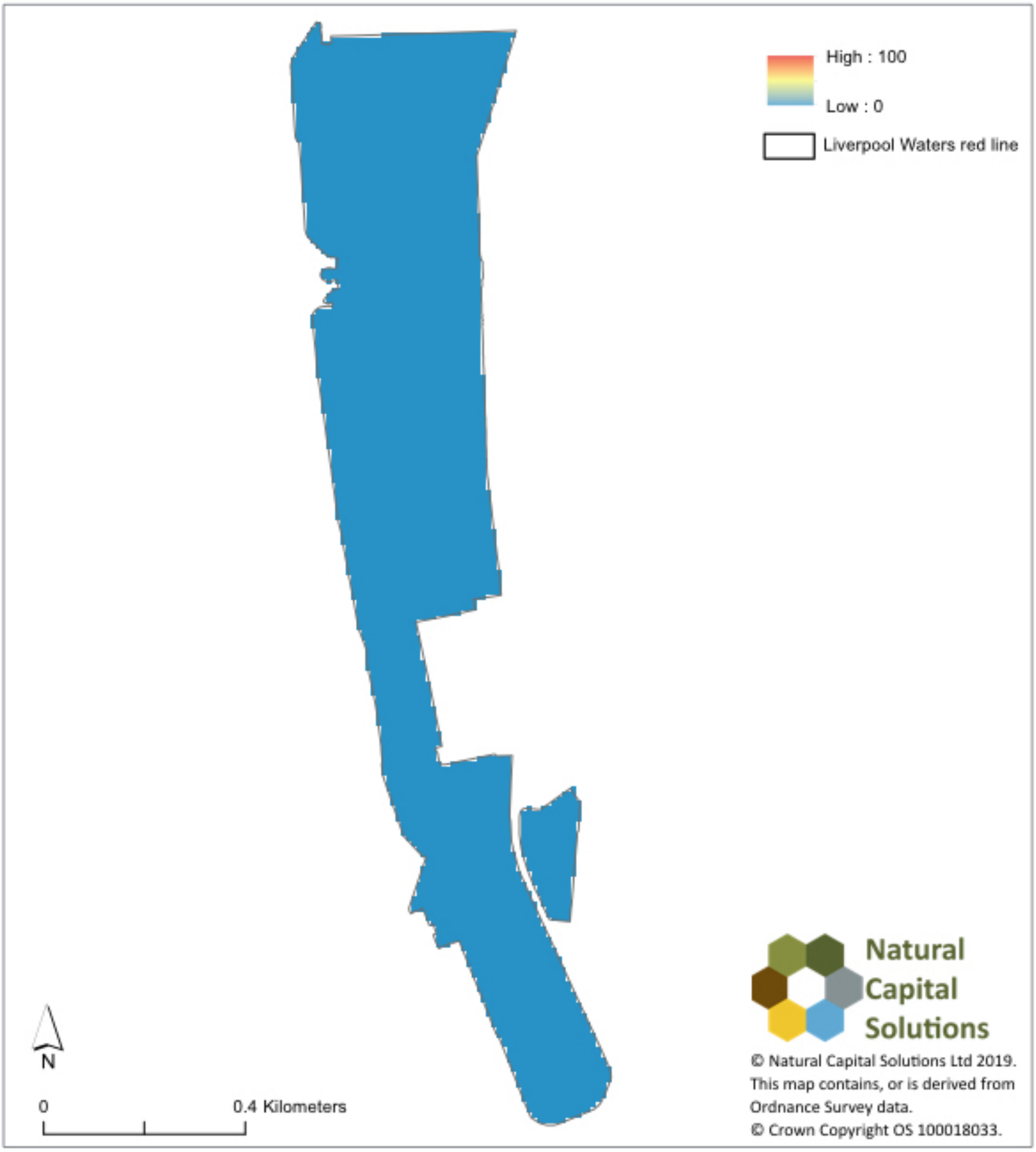


3.3 Carbon sequestration

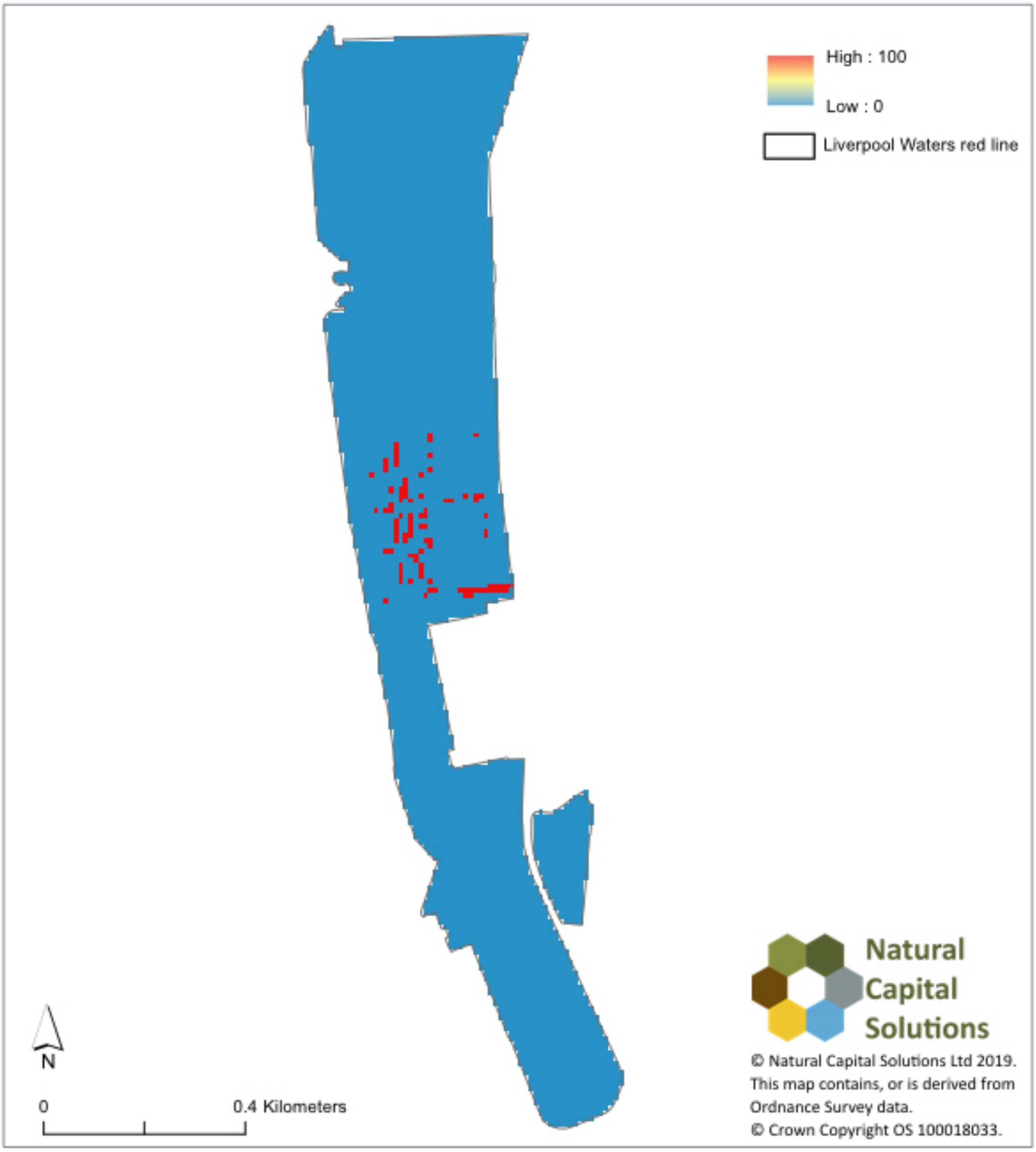
What is it and why is it important?
Carbon is sequestered (captured) by growing plants. Plants that are harvested annually (e.g. arable crops, improved grassland) will be approximately carbon neutral over the course of a year as the sequestered carbon is immediately harvested. There is very little information about sequestration in other habitats (apart from woodland), but these are likely to be very low. Therefore, estimates are solely based on woodland carbon sequestration.

Results
The baseline carbon sequestration rate map (Map 6) shows that there is no carbon sequestered at the baseline site. This is because there are no trees. Including trees has been an important component of the Liverpool Waters design so far. As a consequence carbon is sequestered in the masterplan (Map 7). The areas in red on the map show high sequestration where the trees are located in the central park, in the residential streets, and along the Northern Link Road. The majority of the woodland in the masterplan scenario are broadleaved species.
Baseline score = 0 **Masterplan score = 1.6** **Change = + 1.6**

Map 6. Carbon sequestration Liverpool Waters baseline.



Map 7. Carbon sequestration Liverpool Waters masterplan.

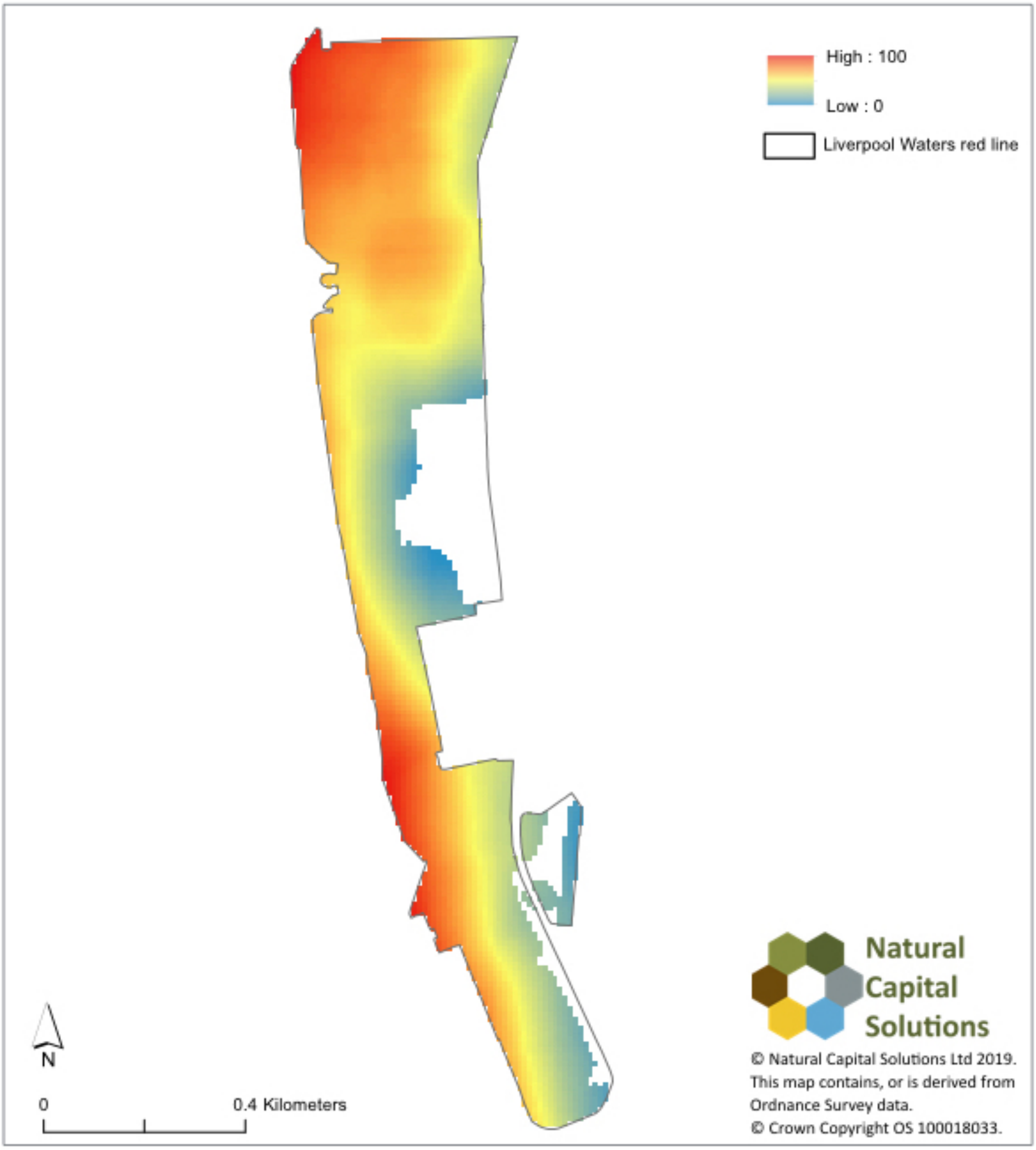


3.4 Climate regulation capacity

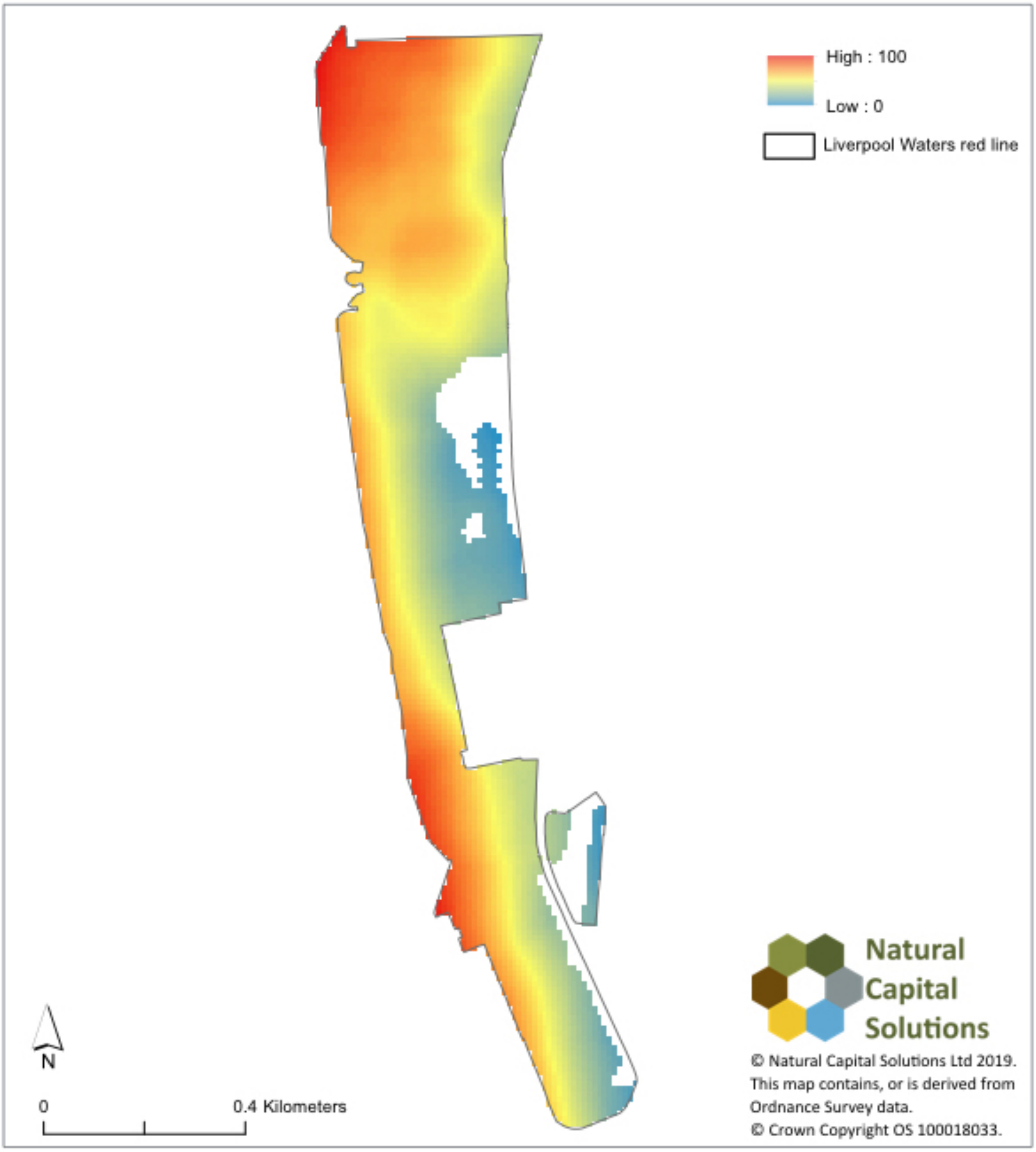
What is it and why is it important?
Land use can have a significant effect on local temperatures. Urban areas tend to be warmer than surrounding rural land due to a process known as the "urban heat island effect". This is caused by urban hard surfaces absorbing more heat, which is then released back into the environment, coupled with energy released by human activity such as lighting, heating, vehicles and industry. Climate change impacts are predicted to make the overheating of urban areas and urban buildings a major environmental, health and economic issue over the coming years. Natural vegetation, especially trees / woodland and rivers, are able to have a moderating effect on local climate. Local climate regulation capacity estimates the capacity of natural habitats to cool the local environment and cause a reduction in urban heat maxima.

Results
The local climate regulation capacity model is based around woodland / scrub and water features, which are the most effective habitats at regulating local climate. The baseline climate regulation map (Map 8) is very similar to that of the baseline (Map 9). The highest provision of this service in both (shown in red) are the docks themselves. The addition of the woodland in the Central Docks shows a low climate regulation capacity that is not present in the baseline map. However, there is a slight increase in the blue in the masterplan map, which indicates a slightly lower provision of this service around the residential and business developments of the Central Docks neighbourhood, compared to the same area in the baseline map. This has lowered the capacity score for this service very slightly from baseline to masterplan.
Baseline score = 41.5 **Masterplan score = 39.3** **Change = - 2.2**

Map 8. Climate regulation capacity Liverpool Waters baseline.



Map 9. Climate regulation capacity Liverpool Waters masterplan.



3.5 Climate regulation demand

What is it and why is it important?

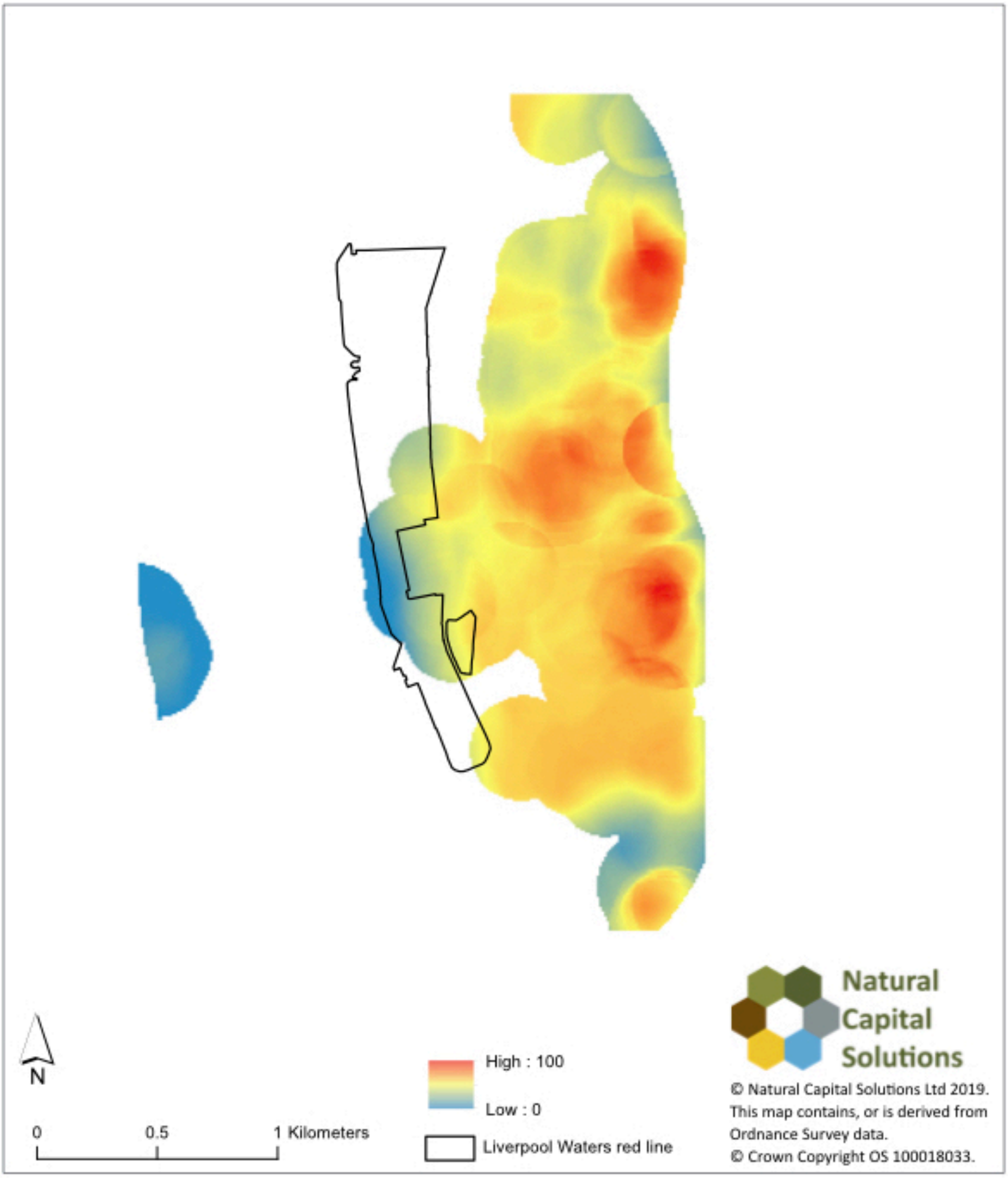
Local climate regulation demand estimates societal and environmental need for ecosystems that can regulate local temperatures and reduce the effects of the urban heat island. Local climate regulation demand combines one indicator showing the location of areas suffering from the urban heat island effect (the proportion of sealed surfaces), with two indicators showing societal need for local climate abatement (population density, and proportion of the population in the highest risk age categories – defined as under 10 and over 65). Scores are on a 1 to 100 scale, relative to values present within the study area.

Results

The demand for climate regulation (Map 10) is presented for the baseline only, as the masterplan demand is very similar. The buffer area is also included as the demand for the services provided at the site are likely to be largely from outside of the Liverpool Waters site. The demand for the climate regulation service is at its highest in the densest most built up parts of Liverpool city centre (see the red areas on the map), with patterns of demand influenced by urban layout and the presence of parks and other green spaces. Under the masterplan the local population will be much increased in the Central Docks area, so the demand for this ecosystem service will increase, but this is not large enough to change the overall average demand score significantly.

Baseline score = 57.9

Map 10. Climate regulation demand Liverpool Waters baseline and buffer.



3.6 Air quality regulation

What is it and why is it important?

According to the World Health Organisation, air pollution is the greatest environmental health risk in Western Europe and globally. In the UK alone, it is estimated to have an effect equivalent to 29,000 deaths each year and is expected to reduce the life expectancy of everyone in the UK by 6 months on average, at a cost of around £16 billion per year (Defra 2019). Air pollution also contributes to climate change, reduces crop yields, and damages biodiversity.

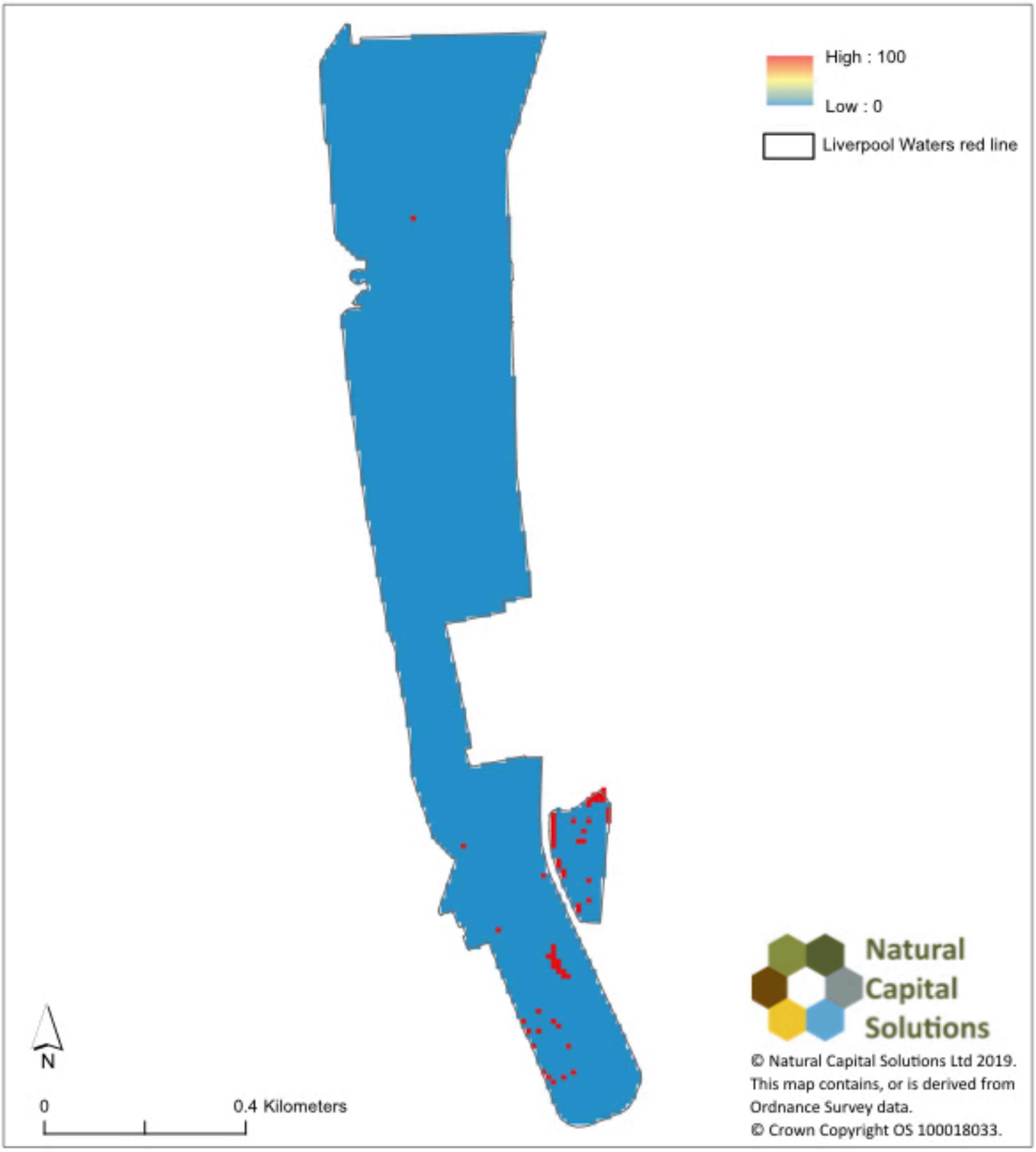
Air purification capacity estimates the relative ability of vegetation to trap airborne pollutants or ameliorate air pollution. Vegetation can be effective at mitigating the effects of air pollution, primarily by intercepting airborne particulates (especially PM_{10} and $PM_{2.5}$) but also by absorbing ozone, SO_2 and NO_X. Trees provide more effective mitigation than grass or low-lying vegetation, although this varies depending on the species of plant. Coniferous trees are generally more effective than broadleaved trees due to the higher surface area of needles and because the needles are not shed during the winter. The ability of the woodland and grassland habitats of the baseline to absorb two of these key pollutants, $PM_{2.5}$ was quantified and mapped.

Results

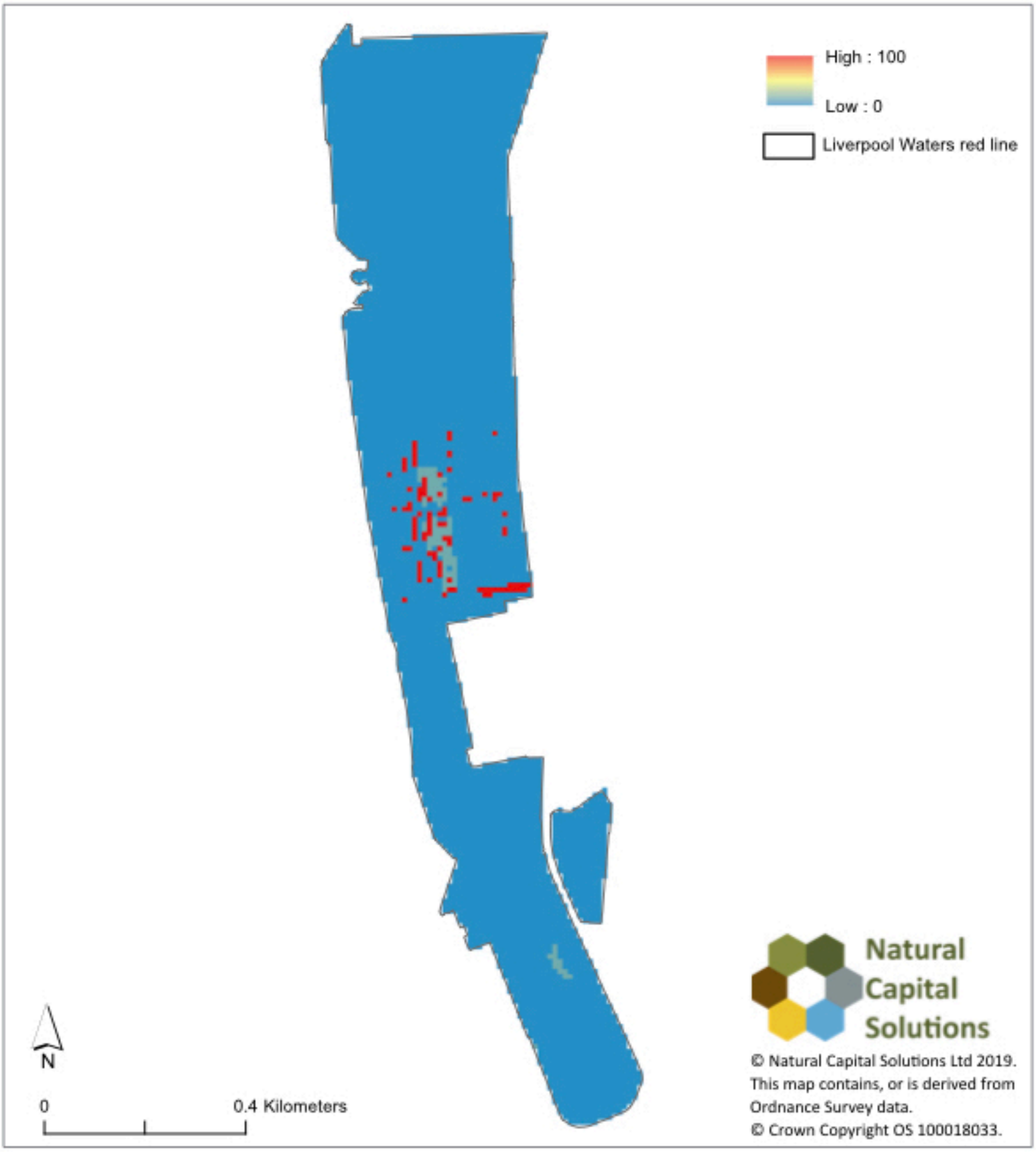
As the capacity of the natural environment to intercept and absorb the pollutant $PM_{2.5}$ (Map 11) is largely dependent on trees, the score for this service is low for the baseline. The highest rates of air pollution regulation is delivered by a line of trees on the very edge of the King Edward Triangle and patches of grassland there and in the Princes Dock. The masterplan includes woodland and street trees in the Central Docks areas, so the highest rates of air pollution regulation service can be seen here (Map 12). The score for this service, therefore, increases from the baseline to the masterplan. However, it remains reasonably low as the percentage of the site that is covered with trees is quite low.

Baseline score = 0.1 **Masterplan score = 0.87** **Change = + 0.86**

Map 11. Air pollution regulation $PM_{2.5}$ Liverpool Waters baseline.



Map 12. Air pollution regulation $PM_{2.5}$ Liverpool Waters masterplan.



3.7 Air pollution regulation demand

What is it and how is it measured?
Air purification demand estimates societal and environmental need for ecosystems that can absorb and ameliorate air pollution. Demand is assumed to be highest in areas where there are likely to be high air pollution levels and where there are lots of people who could benefit from the air purification service.

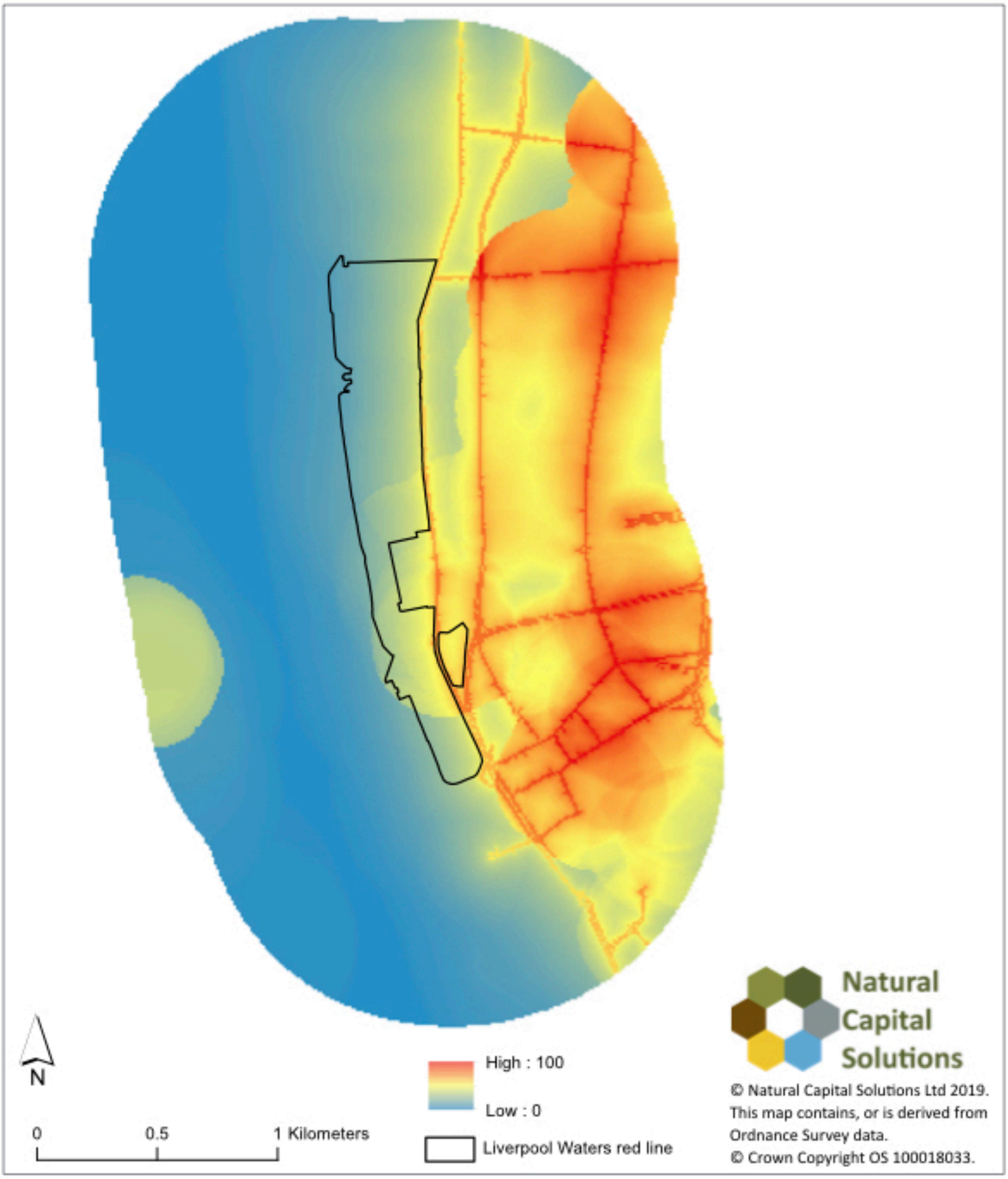
The model combines two indicators of air pollution sources (log distance to roads, and % cover of sealed surfaces) and two indicators of societal need for air purification (population density, and Index of Multiple Deprivation health score). The scores for each indicator were normalised and combined with equal weighting. The final score was then projected on a 0 to 100 scale, relative to values present within the study area.

Results
As with the previous demand map we have presented it for the baseline only, and for a wider area than just the Liverpool Waters site (Map 13). The demand for air pollution regulation is highest in the most densely urban areas of Liverpool city centre. This is because there will be both higher air pollution levels and higher populations that would benefit from better air quality. The main road network is also clearly visible as a major pollution source, and where these main roads pass through built up areas, there is increased demand for air purification.

Under the masterplan condition, particularly in the Central Docks area, there will be residential dwellings that do not exist in the baseline, therefore the demand for air quality regulation will increase. However, overall the average score for demand would not increase that much, as the highest demand will remain outside of the Liverpool Waters site in the city of Liverpool. The trees around the streets and the northern link road in the masterplan are well placed to provide this service to the new residents.

Baseline score = 26.3

Map 13. Air pollution regulation demand Liverpool Waters baseline and buffer.



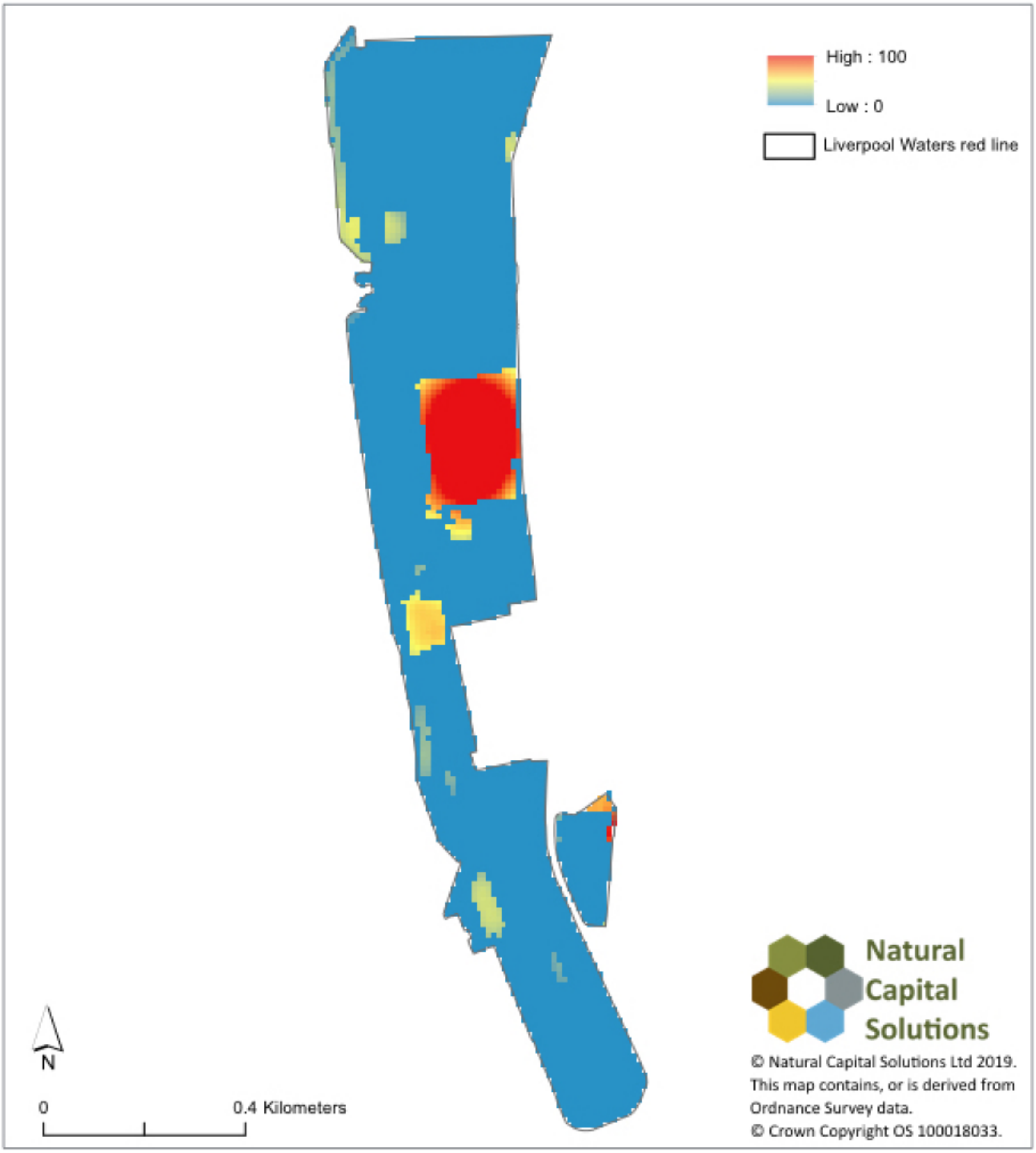
3.8 Noise regulation capacity

What is it and why is it important?
Noise regulation capacity is the capacity of the land to diffuse and absorb noise pollution. Noise can impact on health, wellbeing, productivity and the natural environment and the World Health Organisation (WHO) have identified environmental noise as the second largest environmental health risk in Western Europe (after air pollution). It is estimated that the annual social cost of urban road noise in England is £7 to £10 billion (Defra 2013). Major roads, railways, airports and industrial areas can be sources of considerable noise, but use of vegetation can screen and reduce the effects on surrounding neighbourhoods. Complex vegetation cover such as woodland, trees and scrub is considered to be most effective, although any vegetation cover is more effective than artificial sealed surfaces, and the effectiveness of vegetation increases with width.

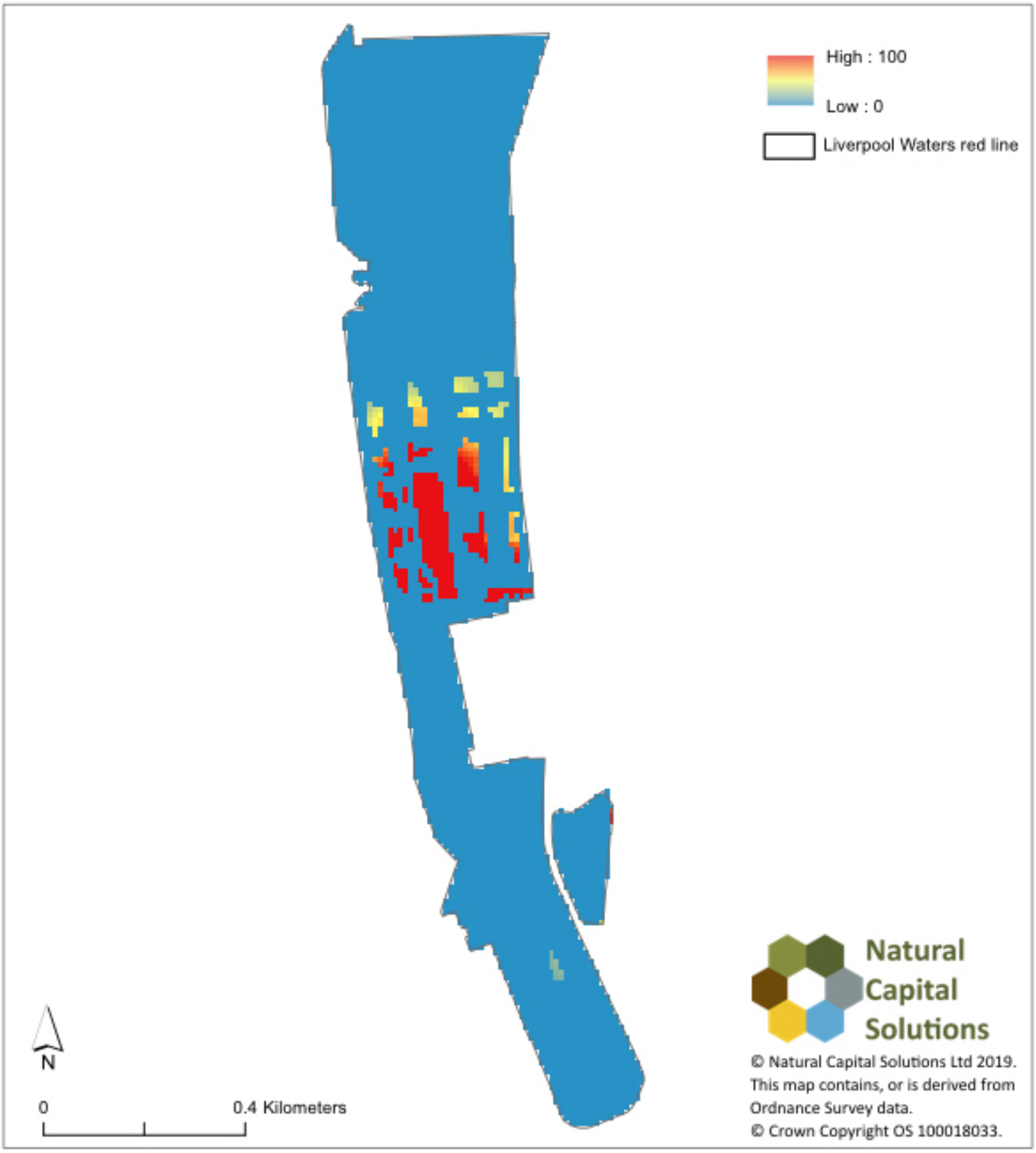
Results
Woodland is by far the most effective habitat at absorbing noise. However, the effects are modest, with reductions of 2-4 dB typically recorded across dense tree belts. In the baseline condition (Map 14), there is a small line of trees on the edges of King Edward Triangle, along with some short perennial habitat here and in the Central Docks area that contributes to the provision of this service. In the masterplan (Map 15), the central park, woodland, street trees and private gardens provide the noise regulation services. However, the level of provision of this service decreases very slightly from baseline to masterplan. This is due to the supporting natural capital being more broken up in the masterplan. This is a small decrease, and the level of noise provision in the baseline may be artificially high because of the way the vegetation has been classified in the original phase 1 survey of the baseline site.

Baseline score = 3.6 **Masterplan score = 2.1** **Change = - 1.5**

Map 14. Noise regulation capacity Liverpool Waters baseline.



Map 15. Noise regulation capacity Liverpool Waters masterplan.



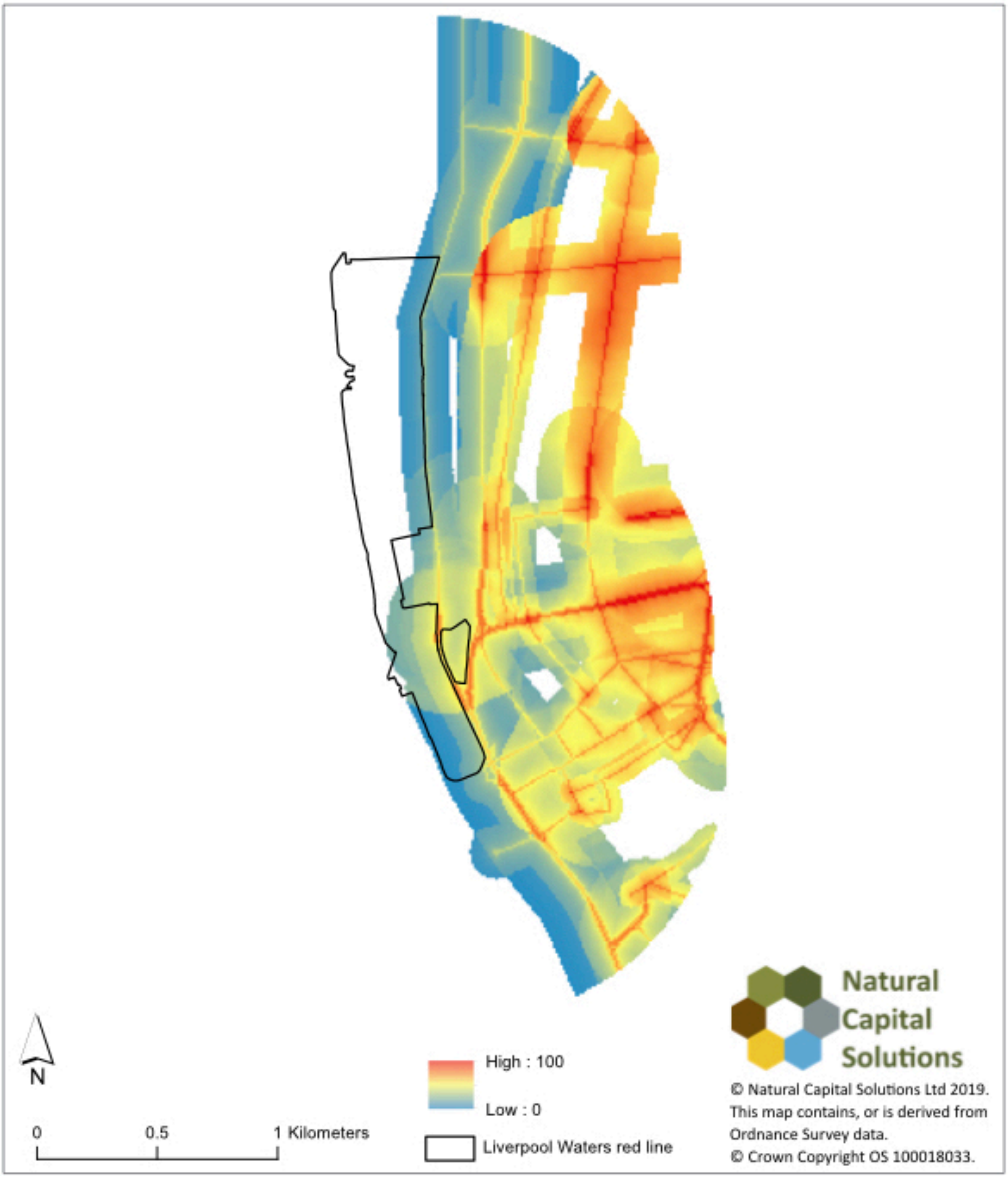
3.9 Noise regulation demand

What is it and how is it measured?
Noise regulation demand estimates societal and environmental need for ecosystems that can absorb and reflect anthropogenic noise. The model combines one indicator that maps noise sources (inverse log distance to different road classes and railways) and two indicators of societal demand for noise abatement (population density, and Index of Multiple Deprivation health scores). Scores are on a 1 to 100 scale, relative to values present within the study area.

Results
Noise regulation demand (Map 16) is presented over a larger area and for the baseline only, as with the previous demand maps. Demand is greatest in urban areas close to major roads within the Liverpool city centre, as these contain large populations, with potentially poor health scores, that would benefit from noise abatement from the main roads. There will be an increased demand for noise regulation in the masterplan, but this will be very small, as there are no main roads planned, and the design discourages car use in favour of walking and cycling.

Baseline score = 36.3

Map 16. Noise regulation demand Liverpool Waters baseline and buffer.



3.10 Water flow capacity

What is it and why is it important?

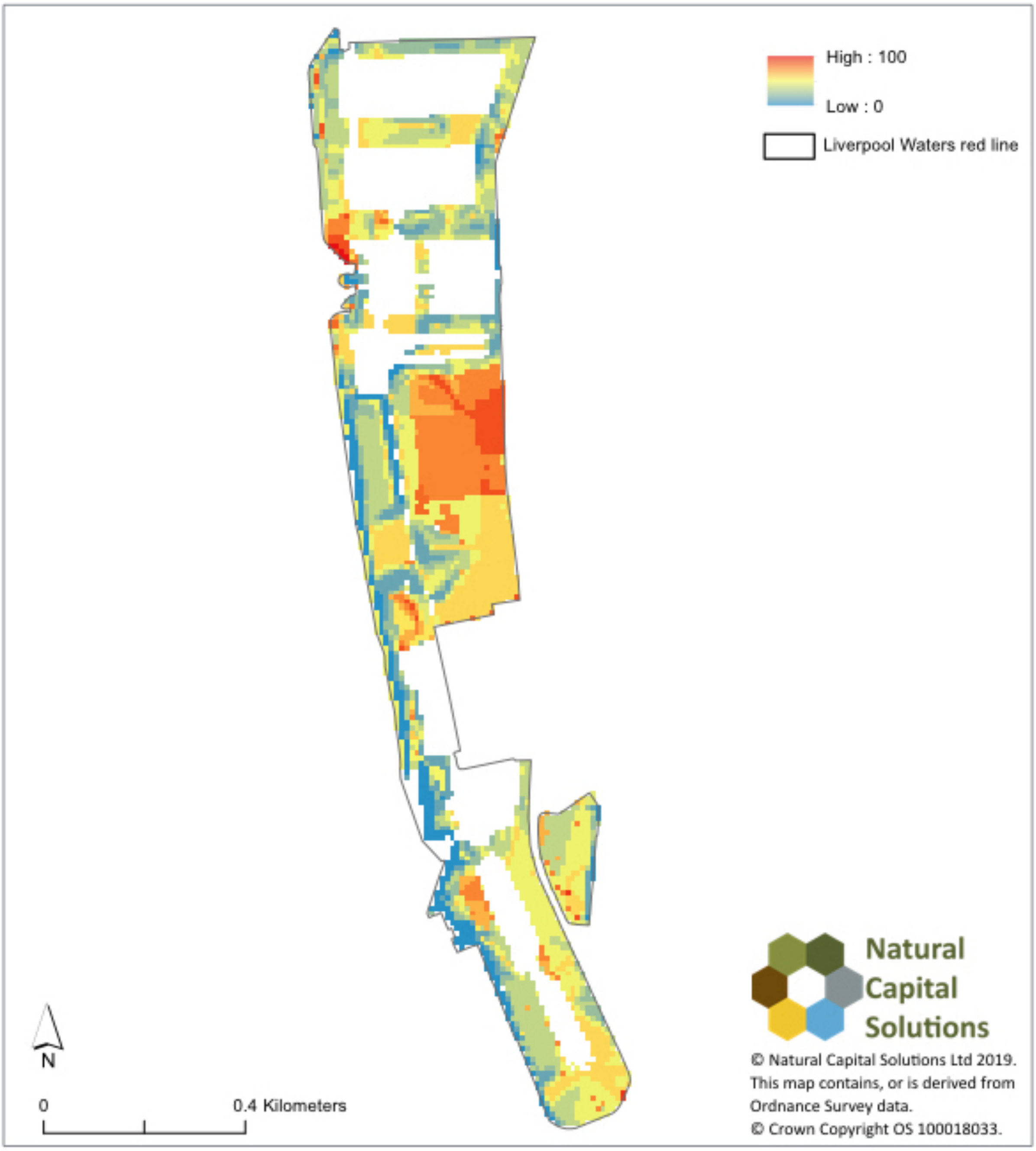
Water flow capacity is the capacity of the land to slow water runoff and thereby potentially reduce flood risk downstream. Following a number of recent flooding events in the UK and the expectation that these will become more frequent over the coming years due to climate change, there is growing interest in working with natural process to reduce downstream flood risk. These projects aim to “slow the flow” and retain water in the upper catchments for as long as possible. Maps of water flow capacity can be used to assess relative risk and help identify areas where land use can be changed.

Results

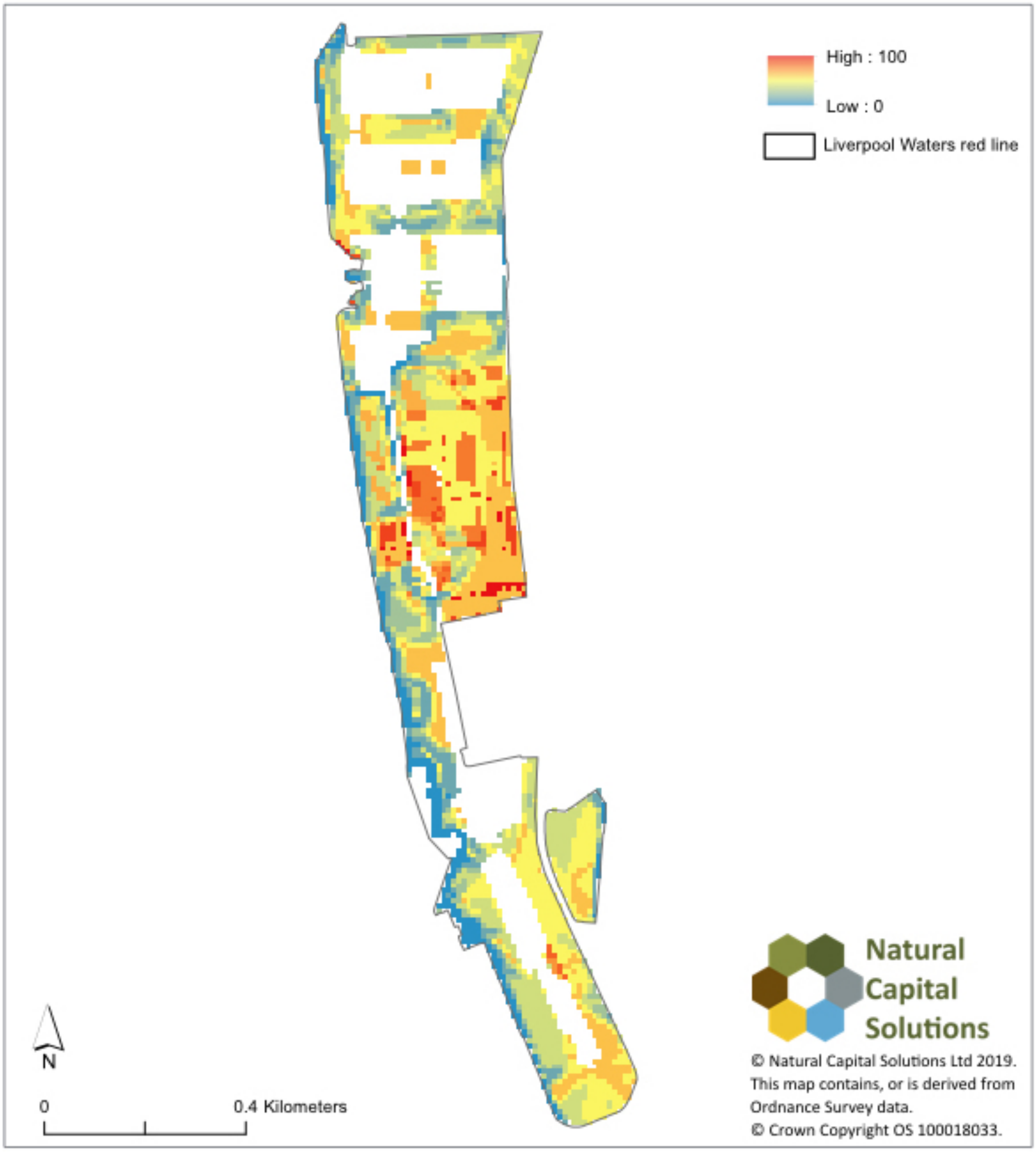
The best locations for slowing water runoff are areas of woodland on flat land and permeable soils. The worst areas (blue on the map) are those with impermeable surfaces. The areas of highest provision of this service in the baseline (Map 17) are the areas of vegetated surfaces, for instance the short perennial (Central Docks) and amenity grassland. In the masterplan (Map 18) the highest areas of provision are in similar locations, but are more fragmented in the Central Docks area, coinciding with the central park, street trees and residential gardens. Overall, the capacity for slowing water runoff is expected to show a very slight decrease following development. As with noise regulation service, the baseline provision may be artificially high because of the way the vegetation has been classified in the original phase 1 survey. Much of the vegetation would have been growing through sealed surfaces, so have no exposed soil or water take up.

Baseline score = 36.9 **Masterplan score = 34.3** **Change = -2.6**

Map 17. Water flow Liverpool Waters baseline.



Map 18. Water flow Liverpool Waters masterplan.



3.11 Water quality capacity

What is it and why is it important?

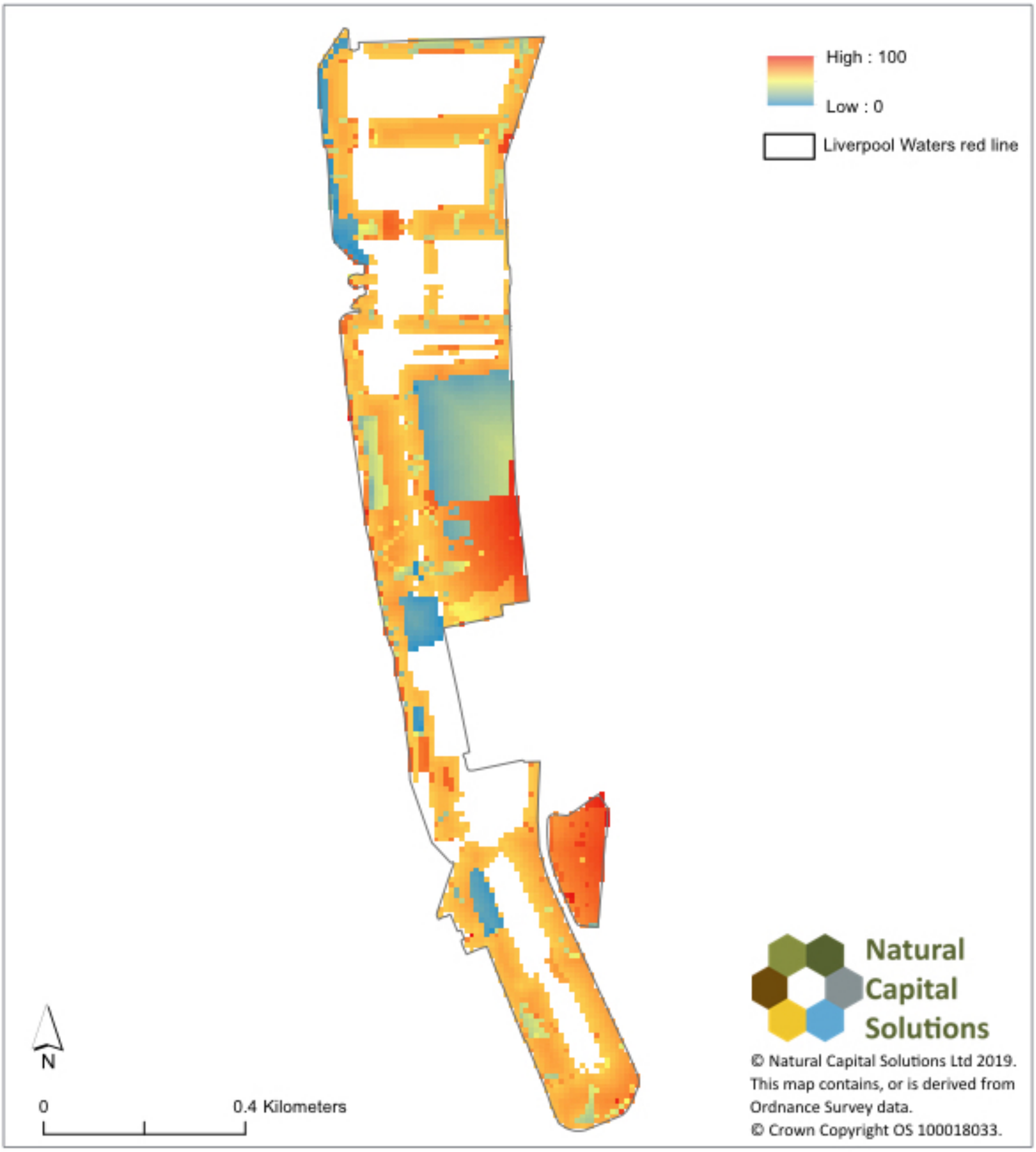
Water quality capacity maps the risk of surface runoff water becoming contaminated with high pollutant and sediment loads before entering a watercourse, with a higher water quality capacity indicating that water is likely to be less contaminated. There are three indicators on which the model is based, distance to watercourse, slope length and land use erosion risk.

Results

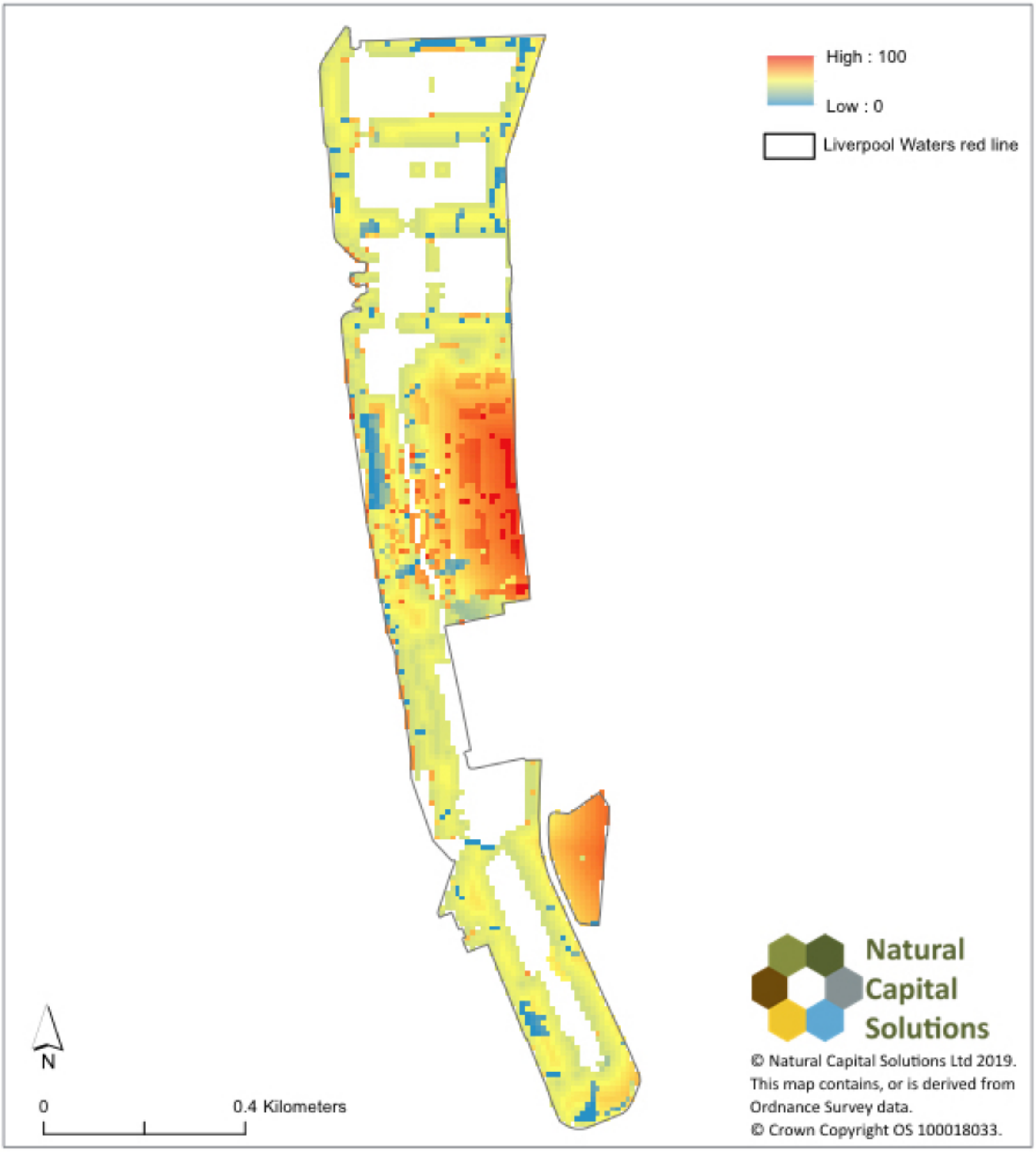
The baseline (Map 19) is able to provide the water quality service reasonably well. However, this is mainly due to patches of grassland and scrub habitats, but also because sealed surfaces, although not good in terms of water filtering, do not contribute massively to erosion that can then be washed into watercourses. The provision of this service increases in the masterplan (Map 20). This is due to the increase in the grassland habitats (park and gardens), and the introduction of trees, which help to limit the erosion from the soil.

Baseline score = 47.2 Masterplan score = 52.7 Change = + 5.5

Map 19. Water quality Liverpool Waters baseline.



Map 20. Water quality Liverpool Waters masterplan.



3.12 Accessible nature capacity

What is it and why is it important?

Access to green space is being increasingly recognised for the multiple benefits that it can provide to people. In particular there is strong evidence linking access to green space to a variety of health and wellbeing measures. Research has also shown that there is a link between wellbeing and perceptions of biodiversity and naturalness. Natural England and others have published guidelines that promote the enhancement of access, naturalness and connectivity of green spaces.

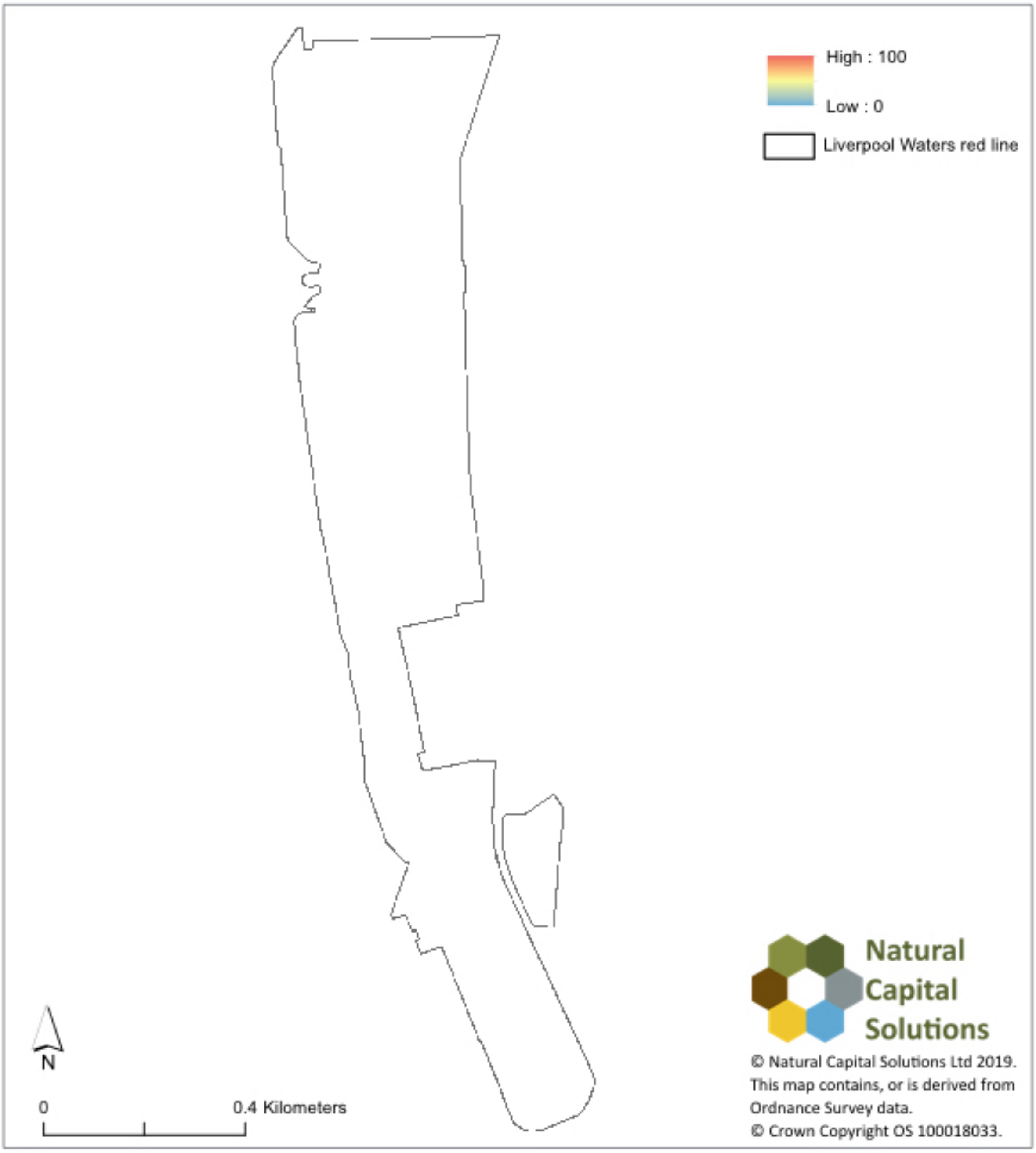
The two key components of accessible nature capacity are therefore public access and perceived naturalness. Both of these components are captured in the model, which maps the availability of natural areas and scores them by their perceived level of "naturalness".

Results

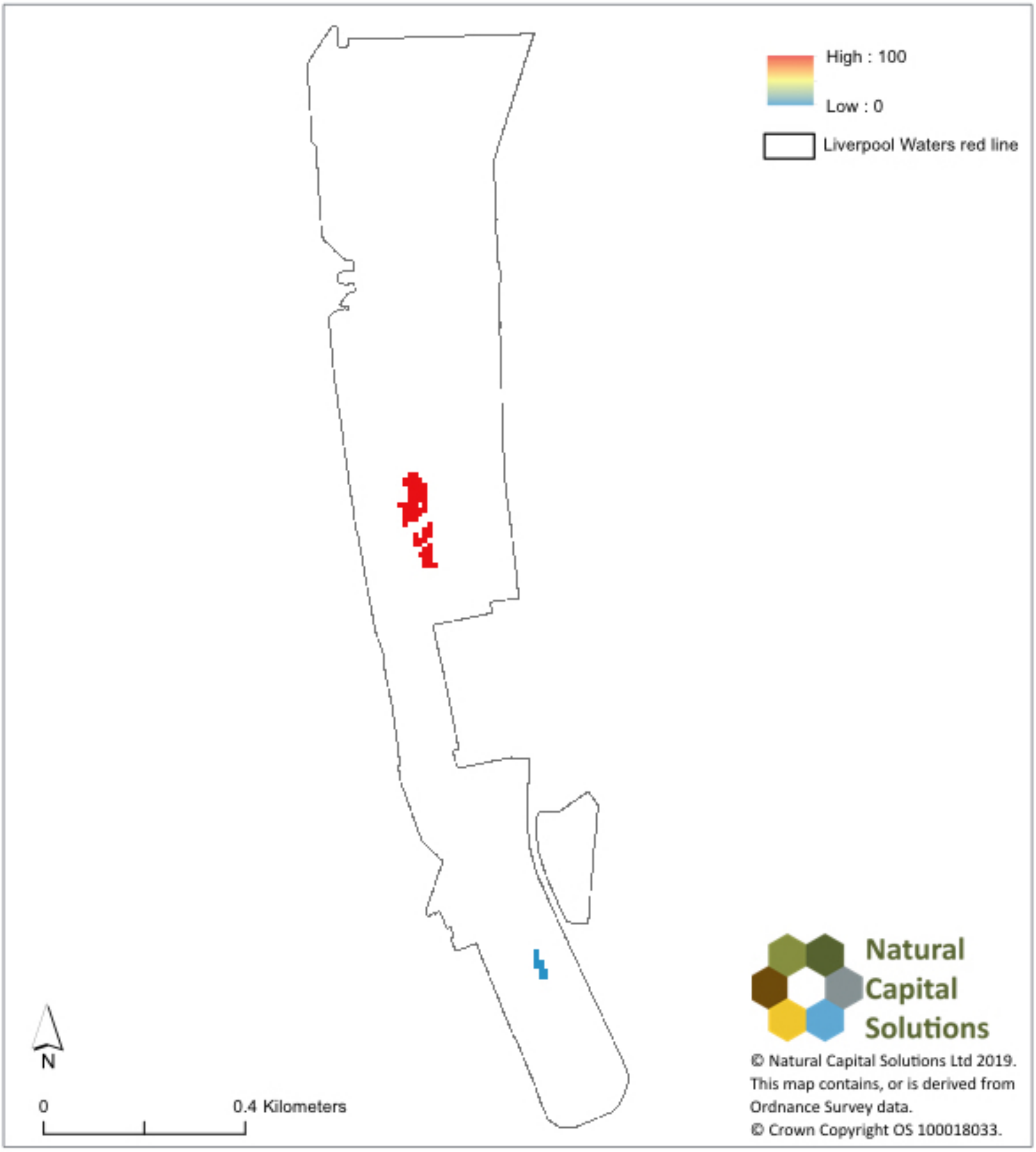
Under the baseline condition (Map 21) there is no provision of the accessible nature service, as there is no public access at all to the site. In the masterplan (Map 22) there is public access to the park in the Central Docks neighbourhood, and an area of amenity grassland in the Princes Dock area. The score, therefore, increases from baseline to masterplan.

Baseline score = 0 **Masterplan score = 20.9** **Change = + 20.9**

Map 21. Accessible nature Liverpool Waters baseline.



Map 22. Accessible nature Liverpool Waters masterplan.



4. Baseline and masterplan ecosystem service valuations

It was possible to value the provision of carbon sequestration and air pollution regulation that were mapped in Section 3. There were some additional services that we were also able to quantify but not map, these include:

- Timber production
- Water recreation
- Physical health
- Mental health

All these services are presented below as a physical flow, annual flow and a present value calculated over 50 years. The HM Treasury discount rate of 3.5% is used in all cases but physical health and well-being, where a discount rate of 1.5% is suggested. The pollution regulation service also applies a 2% uplift to reflect assumptions that willingness to pay for health will rise in line with economic growth (Defra 2019).

Carbon sequestration

The annual physical flow of carbon sequestration in the baseline condition is 0.36 tonnes of CO_2e per year, which has a monetary flow value of £25 (Table 2). The present value of this over a 50-year period is £1,424. This is because there are no trees in the Liverpool Waters site, other than a line on the edge of the King Edward Triangle. In the masterplan, due to the additional woodland and street trees in the Central Docks neighbourhood the carbon sequestration has increased with 5.55 tonnes of CO_2e per year being sequestered, which has a monetary flow value of £377 (Table 2). The present value of this over a 50-year period is £21,723. These values have been calculated using the estimated central non-traded carbon values (DBEIS 2019) for each of the 50 years starting in 2019.

Table 2. Carbon sequestration.

Woodland type	Annual physical flow (t/Co_2e/yr)	Annual monetary flow (central value £2019)	Present value (£ PV)
Baseline	0.36	25	1,424
Masterplan	5.55	377	21,723
Change	+5.19	+352	+20,299

Air pollution regulation

The value of the air pollution regulation service was based on the physical flow of the service provided by both woodland and grass habitats. These habitats in the Liverpool Waters baseline capture 0.002 tonnes per year of $PM_{2.5}$, which has an annual value of £512, and a present value of £17,782 (Table 3). There is now strong evidence to show that fine particles such as these increase human mortality and morbidity from cardiovascular and respiratory diseases. As a result the damage costs avoided are relatively high, even though the capacity for the regulation of air pollution is quite low in the site. The physical and monetary flows from the regulation of SO_2 are much lower than $PM_{2.5}$ (Table 3), and are very small. This is due to the lack of trees at the site, and the very limited areas of grassland. The woodland and grassland habitats have increased in the Liverpool Waters masterplan condition. Therefore, the capacity of the air pollution regulation service has increased. The masterplan captures 0.035 tonnes per year of

$PM_{2.5}$, which has an annual value of £11,309, and a present value of £393,157 (Table 3). The regulation of SO_2 has also increased, but remains low.

Table 3. Air pollution regulation.

Habitat	Annual physical flow (tonnes/yr)	Annual monetary flow (£2019)	Present value (£ PV)
$PM_{2.5}$			
Baseline	0.002	512	17,782
Masterplan	0.035	11,309	393,157
Change	+0.033	+11,821	+375,375
SO_2			
Baseline	0.0003	2	57
Masterplan	0.003	19	670
Change	+0.0027	+17	+613

Timber production

What is it and why is it important?

Timber production measures the average annual yield of woodland. This is not a particularly important service in this urban setting, but it is a useful way of valuing the woodland resource.

Results

The woodland and street trees included in the Central Docks neighbourhood under the masterplan produces 4.14 cubic metres of timber, an annual flow value of £74 and a present value of £1,889 (Table 4). This is based on the average price for softwood in 2019 taken from the Forestry Commission Coniferous Standing Sales Price Index (Forestry Commission 2019), and the 2015 price for broadleaved timber adjusted for inflation to reflect 2019 prices (ABC 2015).

Table 4. Timber production.

Timber type	Annual physical flow (m^3)	Annual monetary flow (£2019)	Present value (£ PV)
Baseline	0	0	0
Masterplan	4.14	74	1,889
Change	+4.14	+74	+1,889

Recreation (water)

What is it and why is it important?

Recreation dependent on natural capital is an important ecosystem service at Liverpool Waters. There is a well-visited riverside promenade that runs past the site in the baseline and the masterplan. Part of the masterplan is the Isle of Man Ferry terminal, that will attract thousands of visitors to the site. There are large-scale community engagement events that have been held and are planned at the site, many of which depend upon the water assets of the site. We are unable to quantify this recreational activity due to lack of data on the numbers of visitors that might visit the site under both the baseline and masterplan conditions, and what proportion of this recreation would be associated with the natural capital of the site.

Results

We were able to quantify the water recreation service. The Collingwood Dock, part of the Clarence Docks neighbourhood, in the Liverpool Waters site is used by the Friends of Allonby Canoe Club. The Canoe Club use the Dock for free, but otherwise it would cost £45,000 a year. This can be used to value the water recreation service, and is the same for the baseline and the masterplan. It is likely that the recreation service will be higher in the masterplan, but it is not possible to predict for this study. We are unable to put a physical flow on this service, i.e. the number of people who use the Dock for canoeing per year. But the annual monetary flow is £45,000 and the present or asset value of this over a 50-year period is £1.2 million.

Physical Health

What is it and why is it important?

There is growing evidence to demonstrate that access to local green spaces increases health and well-being (Public Health England 2014). Incorporating green space provision into residential developments is important. Local residents need to have opportunities to maintain and enhance their physical and mental health.

In order to estimate the physical health service provision for Liverpool Waters it was essential to estimate the number of people who would visit the green space element of the Liverpool Waters site. We were unable to estimate recreation to the site for the baseline (see above), as whilst there is recreation past the site along the riverside walk, we did not have the data to estimate this and the one-off events held do not always depend directly on the natural capital of the site. Instead we quantify the physical health provision from the additional green space created in the masterplan for Liverpool Waters.

We used the data on the percentage of the population who use parks within 1 km of their home from the Fields in Trust (2018) Revaluing Parks and Green Spaces report. From their survey they found that 66% of residents living within 1km of a park would visit their local park once a month or more. Using UK Census 2011 data to calculate the number of people within 1 km of the park in the Liverpool Waters masterplan, including the number of people estimated to be living and working in the site, we calculate that there will be c. 36,598 visitors per year to the park.

Results

The proportion of the visitors that are likely to meet physical activity guidelines were taken from White et al. (2006). These were then translated into Quality Adjusted Life Years (QALYs) scores, with 30 minutes of moderate to intense physical activity (if taken 52 weeks a year) being equal to 0.0107 of a QALY. The number of visitors to green spaces in Liverpool Waters that meet activity guidelines is estimated at 6709 per year, which is equivalent to 229 QALYs per year (Table 5). This has an annual value of £4.6 million and a present value of £169.2 million.

Table 5. Physical health service provision for the masterplan.

Annual physical flow Active visits*/yr	QALYs/yr	Annual monetary flow (£2019)	Present value (£ PV)
6709	229	£4.6m	£169.2m

* Individuals who met national physical activity guidelines.

Mental health

What is it and why is it important?

Well-being is an aspect of mental health and describes how a person is feeling and how they cope with every-day life. Green space provision has been shown to be important in the maintenance and enhancement of well-being (Public Health England 2014). In the absence of primary survey data, it has been difficult to quantify and value mental health benefits from green space. However, the publication of the well-being survey results in the Fields in Trust (2018) report has opened up an opportunity to capture this important service.

The same data on number of visitors to local parks were used to understand the well-being benefits derived from visiting the local green space provision in the Liverpool Waters masterplan. We used a well-being valuation approach from the Fields in Trust report (2018). A value of £8.47 per visit was estimated to be the cost an individual would need to replace the life satisfaction derived by using a local park or green space. This figure is based on a survey of the changes in welfare gathered by asking people their subjective well-being.

Results

The number of visitors to local parks estimated for Liverpool Waters was converted into the number of visits per year (3,516,367), using a yearly visit rate (96) of parks within 1 km from home, also derived from the Fields in Trust report (2018). Using this approach we estimated that the individuals using the green space provision in Liverpool Waters would need to earn £29.8 million to replace the life satisfaction derived by visiting the local park. Over 50-years this is a present value of £1.1 billion.

4.1 Sensitivity analyses

A sensitivity analysis was used to demonstrate the low and high estimates of Present Value around the central value presented for each of the ecosystem services benefits valued in the masterplan scenario. Table 6 shows these figures under the masterplan (so the central figure is the same as shown in the masterplan columns of the tables above). This shows the sensitivity of of each benefit, and therefore for the overall natural capital value delivered by the Liverpool Waters development. Net natural capital value ranges from £911.3 million under the lowest benefits estimate, up to £1.9 billion under the highest benefits estimate. This large difference highlights the challenges of placing a monetary value on some services. A key point, however, is that even under the low estimate, the green infrastructure elements of the Liverpool Waters development will deliver a substantial net benefit worth at least £911.3 million. Note also, that the range in values is driven largely by the uncertainty inherent in two ecosystem services – physical health and mental health. The range of benefits provided by that service alone ranges from £84.6 million to £507.6 million and £825.8 million to £1.4 billion respectively.

Table 6. Sensitivity analysis showing low, central and high estimates of benefits under the 2019 Liverpool Waters masterplan. Based on the Present Value of assets over 50 years.

Ecosystem service benefits £2019 PV (50 years)	Low £2019 PV (50 years)	Central £2019 PV (50 years)	High £2019 PV (50 years)
Carbon sequestration	10,405	21,723	33,041
Air quality regulation			
$PM_{2.5}$	82,159	393,157	1.2M
SO_2	174	670	1871
Timber	1,417	1,889	2,361
Water recreation	861,346	1.2M	1.4M
Physical Health	84.6M	169.2M	507.6M
Mental Health	825.8M	1.1Bn	1.4Bn
Total natural capital value	**911.3M**	**1.3Bn**	**1.9Bn**

4.2 Data gaps assumptions and limitations

It is important to note that if we had the data to estimate the overall recreation service provided by the Liverpool Waters site, the annual and present value of this would be one of the highest valued ecosystem services assessed.

Work is progressing rapidly on the calculation of physical and monetary flows of ecosystem services from natural capital assets, but it remains a developing area. A number of ecosystem services remain difficult to quantify and value. Some are highly location specific, for example water flow and impact on downstream flood risk. This can be quantified and valued by running detailed hydrological and flood risk modelling, but it is difficult to generalise. Others, such as water quality can be modelled, but are very difficult to value, while there are additional cultural services, such as aesthetic experiences, cultural heritage, spiritual experience and sense of place that are difficult to even quantify. It should, therefore, be borne in mind that the valuations presented in this section place values on several key benefits, but these are necessarily incomplete.

For the services that have been included here, a range of assumptions have been made, and these are outlined when describing the methodology (see Section B of the Technical Appendix). In addition, a summary of the main uncertainties is provided for each service in Table 7 (below), along with a RAG rating highlighting the overall confidence in each estimate. For most ecosystem services these assumptions are minimal, as established production functions exist, linking natural capital to ecosystem service production, and levels of production to monetary value. For some services, despite fast developing research in relevant areas, broad assumptions have to be made because these links are not clear. This is particularly the case for physical and mental health, and this estimate should, therefore, be used with care.

Table 7. Summary of uncertainties in the calculation of physical flows and monetary values of each natural capital benefit, and an overall assessment of confidence, using a red, amber, green (RAG) rating.

Natural capital benefits	Assessment of uncertainties	RAG rating
Air purification	A lot of uncertainty over change in absorption as trees grow. Also based on averages for broadleaved and coniferous trees and grassland. Valuation follows ONS guidance.	
Carbon sequestration	Well studied, standardised carbon lookup tables available. Valuation uses UK Government carbon price.	
Timber production	Well studied over many years as part of forestry management. Valuation uses market prices.	
Water recreation	The actual market value for the use of the Dock was used.	
Physical and mental health	The most uncertain of the services measured. High uncertainty over both the number of visitors who would make frequent and active visits to the green spaces and the monetary value of these benefits.	

5. Biodiversity and natural capital net gain

In addition to the natural capital assessment, biodiversity was also assessed at the Liverpool Waters site. The biodiversity units were estimated for the baseline and the masterplan conditions to understand whether net gain in biodiversity will be achieved for the development thus far. The latest 'beta test' version of Natural England's Biodiversity Metric 2.0 was used (see Technical Appendix, Section C).

The baseline condition of the site was estimated to be 16.45 biodiversity units. For the masterplan design the number of biodiversity units decreased by 6.93 units to 9.52. This is a decrease of 42%, so net gain has not been delivered across the site. However, the assessment was repeated just for the Central Docks area, as this was the neighbourhood in the masterplan that has the most detailed design for green space provision. In this assessment net gain was not achieved, but it was very close to no net loss (baseline biodiversity units 10.58, masterplan biodiversity units 9.30). This gives an indication of the extent of green space provision that will be required across the other neighbourhoods to achieve biodiversity net gain across the whole development.

The net loss for the Liverpool Waters site as a whole is a little surprising, given that it is a development on largely sealed surfaces with very poor habitat where they do occur. Habitat of much higher quality has been incorporated in the masterplan. The issue in part is due to the tool being more appropriate for less urban habitats, than urban sites and derelict land. The tool uses the new UK Habitat Classification system to categorise habitats, and the very poor quality habitats on sealed surfaces are not well represented in this classification (which is not primarily designed for use in urban areas). It is also not possible to classify the Docks appropriately. Therefore, it is very possible that the biodiversity units calculated inflate the biodiversity value of the Liverpool Waters site at its baseline. This makes biodiversity net gain very difficult to achieve using this tool.

Table 8. Biodiversity net gain assessment for the Liverpool Waters site.

	Biodiversity units
Baseline	16.45
Masterplan	9.52
Change	-6.93

Twelve ecosystem services in total were quantified as part of the natural capital assessment at Liverpool Waters (see Sections 3 & 4). Eight out of the 12 services (Table 9) increased from baseline to masterplan, one service did not change, and three decreased very slightly. This suggests that natural capital net gain has been achieved for Liverpool Waters. The highest gains have been made in the cultural services. Green space provision has been made at the site in the form of a park, which allows public access to the site, and also creates opportunities for increasing physical exercise and well-being locally. It is not only the new residents to the area that will benefit from this, but also people living in Liverpool city centre within 1 km of the site. Although smaller in magnitude there are gains in carbon sequestration and storage, air quality regulation and water quality due to the park, woodland, street trees and gardens included in the masterplan design. Trees play an important role in all of these services. The three services that decline do so very slightly, and in part this may be due to the classification of the habitats in the baseline inflating the ability of the baseline to provide those services. Taken together the Liverpool Waters development delivers an additional £34.4 million of benefits annually, with a present value of £1.3 billion over 50 years compared to the baseline.

It is important to remember that these values are likely to be higher, as we have not been able to value all of the mapped services, and the recreation service provided by the site. It is also possible that people's willingness to pay for a water or green view from their home should be included. Liverpool Waters homes with a water view could potentially sell for 10% more than those that do not.

Table 9. Direction of ecosystem services provision and biodiversity from baseline to masterplan at Liverpool Waters.

Ecosystem service / biodiversity	Baseline	Masterplan	Direction of change
Scores 0-100			
Carbon storage	0.5	2.76	↑
Carbon sequestration	0	1.6	↑
Local climate regulation	41.5	39.3	↓
Air quality regulation	0.1	0.87	↑
Noise regulation	3.6	2.1	↓
Water flow	36.9	34.3	↓
Water quality	47.2	52.7	↑
Accessible nature	0	20.9	↑
Annual physical flows			
Timber production	0m^3	4.14 m^3	↑
Recreation	-	-	↔
Physical health	0 active visits	6709 active visits	↑
Health and well-being	0 visits	3,516,367 visits	↑
Biodiversity units			
Biodiversity	16.45	9.52	↓

6. Conclusions and recommendations

This report has presented the results of an assessment of the potential impact of the Liverpool Waters development on natural capital assets and the ecosystem services (the benefits) that flow from those assets. Taking such an approach has allowed a wide range of benefits to be considered and provides an opportunity to bring into view the overall benefits delivered by the development.

The site prior to development (the baseline) consisted largely of sealed surfaces and water in the form of docks. The habitats that existed were those associated with derelict sites, for example shrub, short perennial and ruderal vegetation. These areas are not habitats growing on open soil, but largely vegetation that is growing through sealed surfaces. The biodiversity units for the site were not high, but arguably the use of the Biodiversity Metric 2.0 tool inflated the biodiversity value of the site somewhat. This resulted in a low provision of benefits, particularly carbon storage and sequestration, air quality regulation, noise regulation, with no provision for cultural services such as access to recreation, physical health and well-being. Where methodology exists to value ecosystem services, the assessment also demonstrated that carbon sequestration, timber production, air pollution regulation, physical health and well-being had little or no value. The provision of the water recreation did have value (present value £1.2 million). The provision of local climate regulation, water flow and quality was reasonable at the site. The demand maps for local climate regulation, noise regulation and air pollution regulation all demonstrated a high demand for these services in the 1.5 km^2 area of Liverpool city centre around Liverpool Waters.

Under the proposed masterplan, where there has been an increase in the quality of habitats incorporated into the site, and provision of green space for access to recreational opportunities, eight out of the twelve ecosystem services assessed increased (Table 8). These are carbon storage and sequestration, timber production, air quality regulation, water quality, access to nature, physical health and well-being. These are all important and valuable services. The water recreation service did not change from baseline to masterplan, while local climate regulation, noise regulation and water flow decreased slightly. This could be in part due to the ecosystem services models assumption that the baseline habitats were of a better quality than they were in reality. Carbon sequestration has increased by 5 tonnes/CO_2e/yr, and therefore by £20,000 in the present value over 50 years, the regulation of $PM_{2.5}$ has increased by 0.03 tonnes/yr, an increase of £375,000 in the present value over 50 years. By far the most valuable services are physical and mental health, due to the provision of green space, increasing the present value from 0 to £169.2 million and £1.1 billion over 50 years respectively. These increases are important because the demand for these services will increase with residential development, and the employees associated with the businesses, and the benefits will also be felt in the area of Liverpool surrounding the site.

Unfortunately, the masterplan does not achieve biodiversity net gain at the site in its current design. It is not far from no net loss if the Central Docks neighbourhood is taken in isolation. However, in part this is due to the difficulties of reflecting a realistic baseline biodiversity quality using the habitat categories supplied in the Biodiversity Metric 2.0 toolkit.

Recommendations

- The masterplan has shown an increase across the majority of services assessed, but there is always room for improving the level of provision. Adding more trees to the design will increase the carbon sequestration, air quality regulation, noise regulation, well-being and sense of place, water flow and quality services (although will not significantly increase the biodiversity units). This is likely to be desirable particularly in the residential areas.

- Inserting structural vegetation into parks and areas that might be intended for amenity grassland, through seeding wildflower meadows (if the locations are appropriate), will help with water flow, quality, and well-being services. Adding green roofs can also be beneficial. This will also increase the biodiversity value for net gain.

- Achieving biodiversity net gain is about the balance of green space to sealed surface, as well as the quality of the habitat. More green space provision could be designed into the Liverpool Waters development, with a focus on creating habitats that link to others in the local area, or that are part of the local plan or strategic sites. If this proves impractical, it may be more beneficial to think strategically about how the biodiversity units can be off-set in the wider Liverpool city area, and in line with the Liverpool City Region's upcoming strategies for achieving a Carbon Neutral City, reduction in air pollution and nature recovery networks.

Technical Appendix

Section A Modelling and mapping ecosystem services

A1. Creating a habitat basemap for the baseline and the masterplan

Before the physical flow or value of ecosystem services can be calculated and mapped, it is necessary to obtain an accurate assessment of the natural capital assets currently present in at the Liverpool Waters site. The most important component of this was to create a habitat basemap for the area.

The habitat basemap was created using EcoServ GIS, a toolkit developed by the Wildlife Trusts, with a number of bespoke modifications. This approach uses OS MasterMap polygons as the underlying mapping unit, and then uses a series of different data sets to classify each polygon to a detailed habitat type and to associate a range of additional data with each polygon. The data that was used to classify habitats in the basemap is shown below.

- OS Mastermap topography layer
- OS VectorMap District data
- OS Open Green space
- CORINE European land cover data
- Priority habitats and phase 1 habitat survey data
- Digital Terrain Model

Polygons were classified into Phase 1 habitat types and were also classified into broader habitat groups. Multiple modifications were made to the EcoServ programme code to enable improved classification of habitats. Furthermore, upon initial completion the basemap was carefully checked and manual alterations were made in a number of places where misclassifications had occurred. Note, however, that the final map was not ground truthed for accuracy, hence some misclassifications are inevitable. The basemap was produced to cover the Liverpool Waters site, plus an additional buffer zone of 1.5 km to ensure that all maps were accurate right to the edge of the main study area.

A2. Ecosystem service models

Once a detailed habitat basemap was created for the baseline, it was then possible to quantify and map the benefits that these habitats (natural capital) provide to people. The following benefits (ecosystem services) have been assessed for this project:

- Carbon storage
- Carbon sequestration
- Air quality regulation and demand
- Local climate regulation and demand
- Noise regulation and demand
- Water flow
- Water quality
- Accessible nature

A variety of methods were used, and these are described for each individual ecosystem service in the sections below. In all cases the models were applied at a 10m by 10m resolution to provide fine scale mapping across the area. The models are based on the detailed habitat information determined in the basemaps, together with a variety of other external data sets (e.g. digital terrain model, UK census data 2011, open space data, and many other data sets and models mentioned in the methods for each ecosystem service). Note, however, that many of the models are indicative (showing that certain areas have higher capacity or demand than other areas) and are not process-based mathematical models (e.g. hydrological models). In all cases the capacity and demand for ecosystem services is mapped relative to the values present within the study area, on a scale from 0-100.

A2.1 Carbon storage

Carbon storage capacity indicates the amount of carbon stored naturally in soil and vegetation. Carbon storage and sequestration is seen as increasingly important as we move towards a low-carbon future. The importance of managing land as a carbon store has been recognised by the UK government, and land use has a major role to play in national carbon accounting. Changing land use from one type to another can lead to major changes in carbon storage, as can restoration of degraded habitats.

The EcoServ GIS carbon storage model was used. This model estimates the amount of carbon stored in the vegetation and top 30cm of soil. It applies average values for each habitat type taken from a review of a large number of previous studies in the scientific literature. As such it does not take into account habitat condition or management, which can cause variation in amounts of carbon stored. It is calculated for each 10m by 10m cell across the study area. Scores are scaled on a 0 to 100 scale, relative to values present within the mapped area.

A2.2 Carbon sequestration

Carbon sequestration from woodland and street trees were calculated following the UK Woodland Carbon Code methodology and look-up tables (Woodland Carbon Code 2018a,b). Coniferous woodland sequestration rates were averaged over a 60-year period and deciduous woodland sequestration rates were averaged over a 100-year period, as this is the length of a typical forestry cycle for deciduous woodland. Information on species composition was taken from the Central Docks Detailed Neighbourhood Masterplan (PLANIT-IE May 2019). The annual sequestration rate for each woodland type were then multiplied by the area of each and added together to give the total annual sequestration estimate for woodland at the site. Maps of the sequestration rate scaled from 0 to 100 were produced.

A2.3 Air quality regulation

The ability of the woodland and grassland vegetation in LCR to absorb two key pollutants, particulate matter ≤2.5µm in diameter ($PM_{2.5}$) and sulphur dioxide (SO_2), was measured. Quantifying the physical flow of the air quality regulation service provided by the woodland and grassland was based on the absorption calculation in Powe & Willis (2004) and the method in ONS (2016). The deposition rates for $PM_{2.5}$ and SO_2 in coniferous woodland, deciduous woodland, and grassland were taken from Powe & Willis (2004). Average background pollution concentrations for $PM_{2.5}$ and SO_2 were calculated using Defra data (Modelling of Ambient Air Quality 2018 and 2001).

The surface area index of coniferous and deciduous woodlands in on-leaf and off-leaf periods was taken from Powe & Willis (2004). The proportion of dry days in 2018 (rainfall <1mm) for north-west England was estimated using MET office regional value data (http://www.metoffice.gov.uk/climate/uk/summaries/datasets). The proportion of on-leaf relative to off-leaf days was estimated at the UK level using the average number of bare leaf days for five of the most common broadleaf tree species (ash, beech, horse chestnut, oak, silver birch) in the UK using the Woodland Trust data averages tool.

A2.4 Air quality regulation demand

Air quality regulation demand estimates societal and environmental need for ecosystems that can absorb and ameliorate air pollution. Demand is assumed to be highest in areas where there are likely to be high air pollution levels and where there are lots of people who could benefit from the air quality regulation service. The model combines two indicators of air pollution sources (log distance to roads, and % cover of sealed surfaces) and two indicators of societal need for air quality regulation (population density, and Index of Multiple Deprivation health score). The scores for each indicator were normalised and combined with equal weighting. The final score was then projected on a 0 to 100 scale, relative to values present within the study area.

A2.5 Local climate regulation provision

Land use can have a significant effect on local temperatures. Urban areas tend to be warmer than surrounding rural land due to a process known as the “urban heat island effect”. This is caused by urban hard surfaces absorbing more heat, which is then released back into the environment, coupled with energy released by human activity such as lighting, heating, vehicles and industry. Climate change impacts are predicted to make the overheating of urban areas and urban buildings a major environmental, health and economic issue over the coming years. Natural vegetation, especially trees / woodland and rivers, are able to have a moderating effect on local climate, making nearby areas cooler in summer and warmer in winter. Local climate regulation capacity estimates the capacity of an ecosystem to cool the local environment and cause a reduction in urban heat maxima.

EcoServ was used to model local climate regulation capacity. The model calculates the proportion of the landscape that is covered by woodland / scrub and water features within a 200m radius around each 10m by 10m cell across the study area. However, temperature regulating effects of woodland and water will also occur in nearby adjacent areas, with the distance of the effect dependent on the patch size of the natural area. To incorporate this effect, a buffer was applied around each woodland / water patch, with wider buffers modelled around larger natural sites.

Note that this model only includes woodland / scrub and water features which provide the most significant effects. All green space is beneficial compared to artificial sealed surfaces, so a future iteration of the model could include all natural surfaces.

The final capacity score was calculated for each 10m by 10m cell across the study area, and was scaled from 0 to 100, relative to values present within the mapped area. High values (red) indicate areas that have the highest capacity to regulate temperatures, keeping them cool in the summer and warmer in the winter.

A2.6 Local climate regulation demand

Local climate regulation demand estimates societal and environmental need for ecosystems that can regulate local temperatures and reduce the effects of the urban heat island. Local climate regulation demand combines one indicator showing the location of areas suffering from the urban heat island effect (the proportion of sealed surfaces), with two indicators showing societal need for local climate abatement (population density, and proportion of the population in the highest risk age categories – defined as under 10 and over 65). Scores are on a 0 to 100 scale, relative to values present within the study area.

A2.7 Noise regulation capacity

Noise regulation capacity is the capacity of the land to diffuse and absorb noise pollution. Noise can impact on health, wellbeing, productivity and the natural environment and the World Health Organisation (WHO) have identified environmental noise as the second largest environmental health risk in Western Europe (after air pollution). It is estimated that the annual social cost of urban road noise in England is £7 to £10 billion (Defra 2013). Major roads, railways, airports and industrial areas can be sources of considerable noise, but use of vegetation can screen and reduce the effects on surrounding neighbourhoods. Complex vegetation cover such as woodland, trees and scrub is considered to be most effective, although any vegetation cover is more effective than artificial sealed surfaces, and the effectiveness of vegetation increases with width.

The EcoServ noise regulation model was used, with some modifications. First, the capacity of the natural environment is mapped by assigning a noise regulation score to vegetation types based on height, density, permeability and year round cover. Next, the noise absorption score in 30m and 100m radii around each point was modelled and the scores combined, which results in wider belts of vegetation receiving a higher score. The score was calculated for each 10 m by 10m cell across the study area, and is scaled from 0 to 100, relative to values present within the mapped area.

A2.8 Noise regulation demand

Noise regulation demand estimates societal and environmental need for ecosystems that can absorb and reduce anthropogenic noise. The model combines one indicator that maps noise sources (inverse log distance to different road classes and railways) and two indicators of societal demand for noise abatement (population density, and Index of Multiple Deprivation health scores). Scores are on a 1 to 100 scale, relative to values present within the study area.

A2.9 Water flow capacity

Water flow capacity is the capacity of the land to slow water runoff and thereby potentially reduce flood risk downstream. Following a number of recent flooding events in the UK and the expectation that these will become more frequent over the coming years due to climate change, there is growing interest in working with natural process to reduce downstream flood risk. These projects aim to "slow the flow" and retain water in the upper catchments for as long as possible. Maps of water flow capacity can be used to assess relative risk and help identify areas where land use can be changed.

A bespoke model was developed, building on an existing EcoServ model and incorporating many of the features used in the Environment Agency's catchment runoff models used to identify areas suitable for natural flood management. Runoff was assessed based on the following two factors and mapped for each 10m by 10m cell across the study area:

- **Roughness score** – Manning's Roughness Coefficient provides a score for each land use type based on how much the land use will slow overland flow.

- **Slope score** – based on a detailed digital terrain model, slope was re-classified into a number of classes based on the British Land Capability Classification and others.

Each indicator was normalised from 0-1, then added together and projected on a 0 to 100 scale, as for the other ecosystem services. Note that this is an indicative map, showing areas that have generally high or low capacity and is not a hydrological model.

A2.10 Water quality capacity

Water quality capacity maps the risk of surface runoff water becoming contaminated with high pollutant and sediment loads before entering a watercourse, with a higher water quality capacity indicating that water is likely to be less contaminated. Note that although urban diffuse pollution is partially captured in the model at catchment scale, the focus is on sedimentation risk from agricultural diffuse pollution, hence built-up areas are not particularly well accounted for in the existing model.

A modified version of an EcoServ model was developed, which combines a coarse and fine-scale assessment of pollutant risk. At a coarse scale, catchment land use characteristics were used to determine the overall level of risk. The percentage cover of sealed surfaces and arable farmland in each sub-catchment was calculated and the values were re-classified into a number of risk classes. There is a strong link between the percentage cover of these land uses and pollution levels, with water quality particularly sensitive to the percentage of sealed surfaces in the catchment.

At a fine scale, a modification of the Universal Soil Loss Equation (USLE) was used to determine the rate of soil loss for each cell. This is based on the following three factors:

- **Distance to watercourse** – using a least cost distance analysis, taking topography into account.

- **Slope length** – using a flow accumulation grid and equations from the scientific literature. Longer slopes lead to greater amounts of runoff.

- **Land use erosion risk** – certain land uses have a higher susceptibility to erosion and standard risk factors were applied from the literature. Bare soil is particularly prone to erosion.

Each of the three fine scale indicators and the catchment-scale indicator were normalised from 0-1, then added together and projected on a 0 to 100 scale. As previously, this is an indicative map, showing areas that have generally high or low capacity and is not a process-based model. High values (red) indicate areas that have the greatest capacity to deliver high water quality.

A2.11 Accessible nature capacity

Access to green space is being increasingly recognised for the multiple benefits that it can provide to people. In particular there is strong evidence linking access to green space to a variety of health and wellbeing measures. Research has also shown that there is a link between wellbeing and perceptions of biodiversity and naturalness. Natural England and others have published guidelines that promote the enhancement of access, naturalness and connectivity of green spaces. The two key components of accessible nature capacity are therefore public access and perceived naturalness. Both of these components are captured in the model, which maps the availability of natural areas and scores them by their perceived level of “naturalness”.

An EcoServ model was used to map accessible nature capacity. In the first step, accessible green spaces were mapped. These were determined from OS Open Green space data, and data sets on local nature reserves, accessible woodlands and others. Green spaces that did not have full public access (e.g. golf courses, institutional grounds) were removed from further analysis. The retained areas were then scored for their perceived level of naturalness, with scores taken from the scientific literature. Naturalness was scored in a 300m radius around each point, representing the visitors’ experience within a short walk of each point.

The resulting map shows accessible areas, with high values representing areas where habitats have a higher perceived naturalness score. Scores are on a 1 to 100 scale, relative to values present within the study area. White space shows built areas or areas with no public access. Larger continuous blocks of more natural habitat types will have higher scores than smaller isolated sites of the same habitat type.

Section B Valuation methodology

This appendix provides details of the methods used to value the following ecosystem services:

- Carbon sequestration
- Timber / woodfuel production
- Air quality regulation
- Recreation
- Physical health
- Well-being

The annual physical and the monetary flows of each service were calculated, and all values were also presented as Present Values over a 50-year time period.

B1.1 Carbon sequestration

The physical flow of this service was calculated as in A2.2 above. Monetary flows were calculated using the Government's non-traded central carbon price for each year for the next 50 years, starting in 2019 (DBEIS 2019). We use the non-traded carbon price because it is a better reflection of the 'real' value of carbon sequestration if it were to be exchanged, than market prices. Using the latter reflects the current institutional set up of carbon markets, rather than the true value of carbon sequestration. The present value (PV) of the ability of the woodland to sequester carbon into the future was calculated by summing the values for each year over the 50-year project period, after discounting using the discount rate suggested in HM Treasury (2019) of 3.5%, and the formula within ONS (2016). The HM Treasury also provides low and high estimates of current and future non-traded carbon prices. These can be used to provide a sensitivity analysis to the economic valuation of this ecosystem service. The low and high non-traded carbon price was used in the sensitivity analysis.

B1.2 Timber/woodfuel production

For existing woodland, annual physical flows of timber/woodfuel production were calculated in terms of average annual yield, by multiplying the yield class of the different species by the area of each woodland type. The average yield classes for each species of woodland type were derived from the woodland carbon code.

The monetary flows for the woodland areas were calculated by multiplying the yield (calculated above) by the standing price of timber or woodfuel, and multiplying by the standard government discount rate for each respective year over 50 years. The average price for softwood in 2019 was taken from the Forestry Commissions Coniferous Standing Sales Price Index (Forestry Commission 2019). The price for broadleaved timber in 2015 ranged from £15 to high quality timber reaching £250 per m^3 standing (ABC 2015). We assume the lowest value here for woodfuel, so in 2019 prices it is £16.23. The present value of the ability of the woodland created to provide timber into the future was calculated by summing the discounted values over a 50-year period. It was assumed that the area of woodland remains static and the unit price was also assumed to be constant. Low and high estimates were calculated to be 0.75 and 1.25 times the central estimate respectively for the sensitivity analyses.

B1.3 Air quality regulation

The physical flow of this service was calculated as in A2.3 above. The air quality regulation service was valued using guidance from Defra that provides estimates of the damage costs per tonne of emissions across the UK (Defra 2019). These are social damage costs based on avoided mortality and morbidity. Therefore, it was assumed that the value of each tonne of absorbed pollutant by the tree stock was equal to the average damage cost of that pollutant. The central damage cost for SO_2 across all locations was £6,498 (£/tonne, 2019 prices). The $PM_{2.5}$ damage cost estimates depend on the location (urban size or rural) and source of pollution. The Liverpool Waters site is in the heart of the city of Liverpool which would be considered to be urban big, and the central damage costs are presented. When calculating the present value over 50 years, the absorption rate was assumed to be constant. The damage cost of $PM_{2.5}$ and SO_2 was adjusted to reflect inflation up to 2019 from 2017, and the value was also subject to an uplift of 2% per annum to reflect the assumption that willingness to pay for health will rise in line with economic growth, as recommended by Defra (2019). Low and high damage costs from Defra (2019) were used in the sensitivity analysis.

B1.5 Water recreation

The Collingwood Dock in the Liverpool Waters site is used by the Friends of Allonby Canoe Club. The Canoe Club has been gifted use of the Dock for free, but otherwise it would cost £45,000 a year. This has been used to value the water recreation service. We were unable to put a physical flow value on this service, i.e. the number of people who use the Dock for canoeing per year. The present value of the water recreation service into the future was calculated by summing the discounted values over a 50-year period. It was assumed that the unit price be constant. Low and high estimates were calculated to be 0.75 and 1.25 times the central estimate respectively for the sensitivity analyses.

B1.6 Physical health

There is now a growing body of evidence to show the positive effect that the natural environment can have on human health and well-being. Monetising these benefits remains a challenge, with mental health in particular lacking a generic measure that is commonly applied (Binner et al. 2017). Physical health is more commonly valued, although methods are still being refined.

We quantify the provision of the physical health service supplied by the additional green space created in the masterplan for Liverpool Waters. It was first necessary to estimate the number of people who will visit the new green space at the site. We used the data on the percentage of the population who use parks within 1 km of their home from survey results outlined in the Fields in Trust (2018) Revaluing Parks and Green Spaces report. The survey was an online survey focused on how people of age 16 and above value and benefit from parks and green spaces within 1 km of their home, and was designed to be comparable with Natural England’s Monitor of Engagement with the Natural Environment (MENE).

From their survey they found that 66% of residents visit their local park once a month or more. This proportion was taken from a survey that included people of 16 years and above only, so we estimated the number of people of this age and over that would live within 1 km of the new park to be created in the Liverpool Waters Central Docks area, using census data in GIS. The number of residents over sixteen estimated to be living in the new Liverpool Waters development (23,000) and the number of people working there (20,000) was added to this. Sixty six percent of this total was 36,598 visitors per year.

These were translated into Quality Adjusted Life Years (QALYs) scores, with 30 minutes of moderate to intense physical activity (if taken 52 weeks a year) being equal to 0.0107 of a QALY. QALY scores have an associated monetary value through estimated savings in health care costs. The physical health benefit was valued by calculating the total number of QALYs by active visitors to sites that meet guidelines, and multiplying this by the QALY value. The social value of one QALY has been estimated to be worth £20,000 (White et al. 2016). Note, however, that the HM Treasury has recently published an update to the Green Book (the Government's key guidance document on appraisal and evaluation), in which the value associated with one QALY has been increased to £60,000 (HM Treasury 2018). Given the large monetary benefit that would be assigned if using the higher QALY figure and the large number of assumptions involved in calculating this value, we have taken a conservative approach and used the £20,000 value for our central estimate, as has been used in previous natural capital assessments. We have, however, used the £60,000 estimate for our upper estimate of value in the sensitivity analysis. The lower estimate was 50% of the central value.

The present value (PV) of the area to deliver physical health benefits into the future was the sum of annual values over the 50-year period, using the discount rates suggested in HM Treasury (2019). Discount rates for QALY effects are recommended at 1.5%, (differing from the 3.5% rate recommended for other service indicators).

A number of assumptions are used in these calculations and the results should therefore be interpreted with caution; it is one of two ecosystem services with the greatest degree of uncertainty out of all those assessed.

B1.7 Mental Health

As mentioned above it has been difficult to quantify and value mental health benefits from green space. However, the publication of the well-being survey results in the Fields in Trust (2018) report has opened up an opportunity to capture this important service.

The same data on number of visitors to local parks as the physical health calculation, were used to understand the well-being benefits derived from visiting the local green space provision in the Liverpool Waters masterplan. We used a well-being valuation approach from the Fields in Trust report (2018). A value of £8.47 per visit was estimated to be the cost an individual would need to replace the life satisfaction derived by using a local park or green space. This figure is based on a survey of the changes in welfare, where people were asked the four Office for National Statistics (ONS) subjective well-being, or in other words life satisfaction, questions (life satisfaction, happiness, anxiety, and sense of purpose see Fields in Trust (2018) p20.). The number of visitors to local parks estimated for Liverpool Waters was converted into the number of visits per year (3,516,367), using a yearly visit rate (96) of parks within 1 km from home, also derived from the Fields in Trust report (2018).

The present value (PV) of the area to deliver mental health benefits into the future was the sum of annual values over the 50-year period, using the discount rates suggested in HM Treasury (2019). Discount rates for QALY effects are recommended at 1.5%, (differing from the 3.5% rate recommended for other service indicators). Low and high estimates were calculated to be 0.75 and 1.25 times the central estimate respectively for the sensitivity analyses.

A number of assumptions are used in these calculations and the results should therefore be interpreted with caution; it is one of two ecosystem services with the greatest degree of uncertainty out of all those assessed.

Section C Biodiversity net gain assessment

The government is likely to mandate biodiversity net gain for development, although this is still not certain as the Environment Bill was re-introduced to Parliament following the general election in January 2020, and is currently being scrutinised by a Public Bill Committee. If it is made compulsory a development is required to achieve a 10% net gain. If 10% net gain is not achieved by a development, there is a chance to design in more green space on site, or to off-set the biodiversity units required to achieve the net gain. To ensure a common approach across England it is expected that the Biodiversity Metric 2.0 will be used. This is a toolkit that has been developed by Natural England and is based on the original Defra biodiversity metric.

The Defra biodiversity metric 2.0 'beta test' version was used (Natural England 2019). This is the latest version of the metric and is currently out for consultation. This is a relatively simple metric that uses habitat as a proxy for biodiversity, with habitat types scored according to their relative biodiversity value. The value is then weighted by how easy or hard it will be to create and how long it will take to reach the target condition of the habitat and its location (i.e. whether it connects up with other habitat). These scores are equivalent to biodiversity units, which allows developers to compare the biodiversity before and after the development.

The biodiversity metric 2.0 tool site habitat baseline, creation and enhancement tabs were populated using the habitat type and area from the basemaps generated for the baseline and the masterplan. The baseline was split into land parcels that corresponded with how the habitats would change in the masterplan condition. The condition of the habitat had not been assessed for the baseline, but from a site visit it was clear that all of these habitats were in poor condition and mostly growing through sealed surfaces. So the quality of all the habitats were assumed to be low. The condition of the habitats to be created was aspirational, considering how practical it would be to create and maintain, and taking into account that the site is a windy exposed maritime location.

The tool was used to calculate the biodiversity net gain across the whole of the Liverpool Waters site, with an additional estimate considering only the Central Docks neighbourhood.

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