PUTTING A VALUE ON THE URBAN FOREST

Burton-upon-Trent
Tree Project

EXECUTIVE SUMMARY

Individual trees and woodlands in towns, including street and garden trees, trees in open spaces, woodlands and hedgerows make up the urban forest. Urban forests provide a wide variety of benefits to communities and the local economy, such as cleaner air, resilience to climate change, enhanced biodiversity and a more attractive place to live.

This study aimed to investigate the benefits delivered by the urban forest in a Staffordshire town. It is hoped that this study – a first for Staffordshire – will inspire other communities to explore their urban forests.

The study area was Burton upon Trent in East Staffordshire, which lies within The National Forest. The study used a methodology called i-Tree Eco, which has been used both in the UK and internationally to evaluate the benefits of urban forests, assigning financial values where appropriate. The study was based on a survey of 250 randomised plots, stratified against deprivation data. Plots of 0.04 hectares (400m2) were surveyed by trained volunteers in August -September 2016.

Survey data was entered into i-Tree Eco software to establish a quantitative baseline of the structure and value of Burton's urban forest for setting objectives and monitoring progress.

KEY FINDINGS FROM THE STUDY:

- The replacement cost of Burton's urban forest is **£54.2 million** – i.e. what it would cost to replace the trees with others that are structurally identical in the same locations.
- The amenity value of Burton's urban forest has an estimated value of **£1,126 million** – i.e what is considered to be the asset value of the whole stock to the community.
- Carbon storage has an estimated value of **£1.23 million** with the urban forest storing 19,800 tonnes of carbon
- The estimated value of carbon sequestration is **£44,800** per year or 722 tonnes, through the long term storage of atmospheric carbon dioxide.
- The estimated value of avoided runoff is **£21,700** per year or 23,700 m^3.
- Pollution removal has an estimated value of **£48,800** per year or 23 tonnes of pollutants per year.

The study found that tree cover in Burton is relatively low at 9.4%, compared to other towns and cities that have completed i-Tree surveys (ranging from 11.4% - 17% for other UK locations). The town is also dominated by younger trees with relatively few large mature trees. The number of species is considered to be low, with 50 species recorded. The three most common species were Beech, Hawthorn and Sycamore.

The results of the survey suggest there is considerable scope to develop and enhance Burton's urban forest and increase the benefits it provides to the town's communities, economy and environment. The report outlines eight aims to achieve this and offers recommendations on how they could be achieved.

KEY MANAGEMENT AIMS:

1. Increase overall tree cover
2. Develop a more diverse age structure to address the dominance of younger trees
3. Improve species diversity of the urban forest to increase resilience
4. Enhance biodiversity
5. Enhance the sense of place and amenity value
6. Increase the contribution of the urban forest to public health outcomes
7. Increase the contribution of the urban forest to the local economy and maximise opportunities from new developments
8. Increase the contribution of the urban forest to climate change resilience and mitigation

To conserve and enhance Burton's urban forest the implementation plan identifies the key next steps to achieve these aims. Four priority zones are outlined where planting will provide particular benefit to communities together with a range of actions for new planting and measures to protect the existing tree stock both within the priority zones and the wider area.

Due to the predominantly urban nature the study area it is likely to be challenging to establish tree cover. A modest target of 1% increase in tree cover has therefore been set for the whole project area for this initial period to reflect the challenges. However it is important that this is reviewed and that a long term strategy is maintained to increase tree cover across the town. Burton may then rightly achieve the aspiration to be recognised as the capital of The National Forest.

ACKNOWLEDGEMENTS

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Project Steering Group members were:

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Kieron Doick (Forest Research), **Kenton Rogers** and **Keith Sacre (Treeconomics)**, **Julia Banbury** and **Ali Glaisher (Staffordshire County Council)** provided technical advice and contributed to data analysis and interpretation.

Mapping was produced by **Shona Frost, Staffordshire County Council.**

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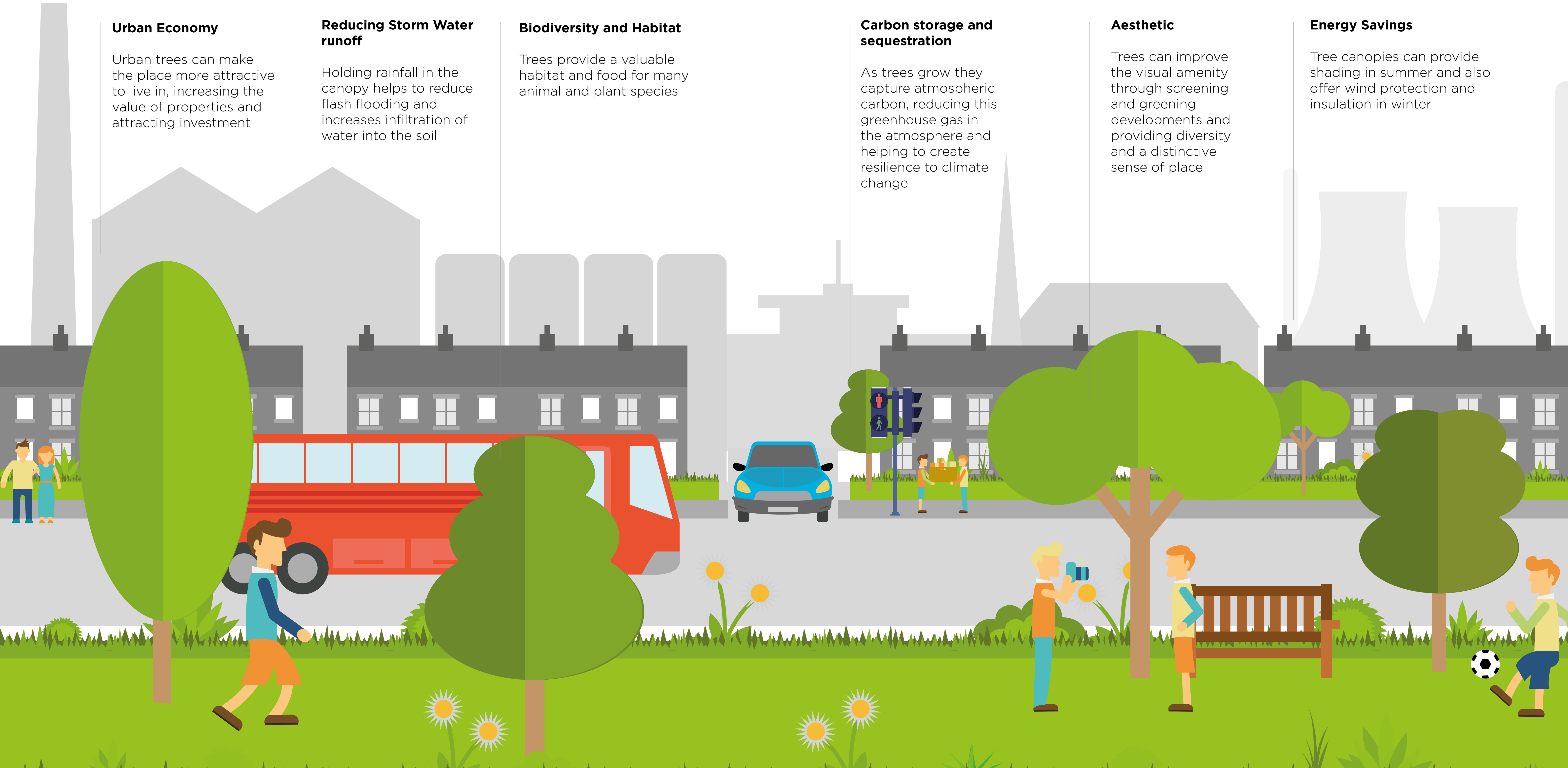
INTRODUCTION

IMPORTANCE OF URBAN FORESTS

Individual trees and woodlands in towns, including street and garden trees, trees in open spaces, woodlands and hedgerows make up the urban forest. Urban forests provide a wide variety of benefits to communities and the local economy which can often go unnoticed or are undervalued. Some of the benefits of urban forests are summarised in Figure 1.

FIGURE 1
Benefits of the urban forest



AIMS OF THE STUDY

The aim of the study was to investigate the benefits delivered by the urban forest in a Staffordshire town, and where possible to estimate the financial value of these benefits. The study used a recognised survey and analysis methodology called i-Tree Eco, which has been used in towns and cities in the UK and internationally. Using the outcomes of the i-Tree survey and existing data, a further aim was to develop an implementation plan to identify how the urban forest could be developed to maximise its benefits to society.

The information and recommendations resulting from the project can be used by a range of stakeholders including planners, highway authorities, conservation groups, community groups and the National Forest Company to steer planting and woodland management to the areas which need it most.

It is hoped that this study – the first of its kind in Staffordshire – will act as a pilot for other areas, inspiring other communities to look at the benefits their urban forests could provide.

THE STUDY AREA
BURTON UPON TRENT

Burton is situated within the River Trent corridor and this has shaped the settlement pattern through its floodplain. Also known as the `Washlands' the floodplain dominates the centre of the town and provides a unique feature and valued recreation resource for residents. Surveys carried out on behalf of East Staffordshire Council show that the majority of residents value Burton's greenspaces but not all use them.

Burton is firmly identified as a brewing town and this has influenced the architecture and character of the town. Many Victorian terraces around the periphery of the town centre have remained more or less intact with no significant post-war clearance / redevelopment schemes taking place for new housing and roads. There has only been modest clearance of Victorian industrial buildings for other uses such as housing and employment uses, so Burton has retained much of its cohesive historic character and form. However, in some areas housing stock is in poor condition associated with pockets of deprivation, economic inactivity and socio-economic problems. The layout of these areas generally has a hard urban form with little soft landscaping, trees and open space.

Burton upon Trent is generally regarded as a moderately densely-developed town, with relatively little green space remaining within it's built up areas and few roadside trees in the town. As the largest town within The National Forest, Burton is a key part of the Forest. This has had, and will continue to have, a profound effect on the town, facilitating the creation of large areas of new publicly accessible woodland within and on the edge of the town.

Burton is set to grow significantly; between 2012-2031 approximately 7000 new homes are proposed on brown and greenfield land, putting pressure on Burton's important green spaces.

Assessing the value of Burton's urban forest will enable the Council and other stakeholders to have a better understanding of the benefits trees provide. This will allow for more informed decisions for future management. The strong connection with The National Forest provides greater potential opportunities to take forward the recommendations from this report.

METHODOLOGY

The study area covered 2,851 hectares and followed the town boundary plus adjacent housing and strategic urban extension allocations identified by East Staffordshire Borough Council.

The area was stratified using the English Indices of Deprivation which measures the risk of premature death and impairment of quality of life through poor physical or mental health. This provided a framework to relate how the urban forest can contribute to regenerating and improving social and economic influences.

250 plots were randomly selected for survey, representing 0.35% of the survey area. The number of plots allocated to each stratified area was in proportion to the size of each stratum. Following this methodology ensured that both public and private land ownership were included, with a balance of plots for each stratum.

Burton's trees were surveyed by volunteers in August and September 2016. Access restrictions prevented all the allocated plots being surveyed with 247 of the target 250 plots being completed. This equated to 32 plots in the most deprived stratum, 66 plots in the above average deprivation stratum, 71 plots in the average deprivation stratum, 73 plots in the below average deprivation strata, and 5 plots in the most deprived strata being completed, shown in Figure 2.

Each plot covered 0.04 ha (400m²) and in line with the i-Tree methodology, the following was recorded:

- **The type of land use e.g. park, residential**
- **The different types of ground cover present in the plot e.g. grass, tarmac**
- **The percentage of the plot:**
  - **Covered by trees[1]**
  - **Covered by hedges**
  - **That could have trees planted in it**
- **Information about trees**
  - **The number of trees and their species**
  - **The size of the trees including height, canopy spread and girth of trunk**
  - **The health of the trees including the fullness of the canopy**
  - **The amount of light exposure the canopy receives**
  - **The amount of impermeable surface (e.g. tarmac) under the tree**
  - **The distance of trees from the nearest building**
- **Information about shrubs with a trunk girth less than 7 cm (species, size and dimensions of shrubs recorded).**

Further details on the i-Tree Eco methodology can be found at:

www.itreetools.org/resources/manuals.php

[1] For the purpose of the project trees with a diameter at breast height (DBH) of 7cm or greater were classified as trees and were surveyed fully. Trees with a DBH less than 7cm were included in the shrub listing.

All the volunteers were provided training in small groups on the i-Tree methodology and loaned all equipment needed for surveying. Access request letters and general information on the project were provided to the volunteers to offer to residents when requesting access permission. Vicki Lui, Staffordshire Wildlife Trust and Lawrence Oates, Burton Conservation Volunteers provided support to volunteers throughout the project.

The project was publicised through local newsletters and stakeholder websites with some direct mailing to Parish Councils, housing associations and large businesses to raise awareness of the project.

Data was entered into i-Tree Eco software and used to measure:

URBAN FOREST STRUCTURE

Number of trees, species composition, age and size class distributions, tree health, and a land-use classification.

POLLUTION REDUCTION

Amount of pollution removed by the urban forest (pollution removal was calculated for ozone, sulphur dioxide, nitrogen dioxide, carbon monoxide and particulate matter <2.5 microns). The financial cost is calculated upon the UK Social Damage Costs for NOx (£14,646 per tonne) and SOx (£1,956 per tonne) only.

CARBON

Total carbon stored (calculated by estimating the trees biomass) and net carbon annually sequestered by the urban forest using the 2016 carbon value of £62 per tonne.

AVOIDED RUNOFF

Yearly avoided runoff attributed to trees, (based upon £0.9141, the standard Severn Trent Water Sewerage volumetric charge).

VALUES

- The Replacement value of the forest (this calculation is based on valuation procedures of the Council of Tree and Landscape Appraisers[2] using tree species, diameter, condition and location information).
- The amenity value (calculated at the CAVAT Quick Method valuation[3], and is intended to consider the stock as a whole to estimate the asset value of these amenity trees for management purposes). It is calculated using a Unit Value Factor of £15.88, and a Community Tree Index (CTI) factor of 100%[4]), as well as the estimated economic value for many of the ecosystem services provision.

2 CTLA: Council of Tree and Landscape Appraisers version 9, as incorporated into i-Tree Eco v6.02

3 CAVAT: Capital Asset Value for Amenity Trees, see www.cavattv.org for further details. The Quick Method (QM) has been adopted for the purposes of this study. QM calculates a base value for each tree (trunk size multiplied by CAVAT Unit Value Factor) and adjusts it according to the Community Tree Index (an adjustment based on location), crown size and condition, and life expectancy. The QM value for each tree is summed and extrapolated for the full assessment area.

4 The CTI factor is a means to reflect in the tree stock's asset value the relative population density of the local area and thus the relative number of those potentially able to benefit from the local authority trees. CTI bands vary from 100% to 250% for densely populated inner city areas. Burton as a low density area has been calculated at 100%.

DATA LIMITATIONS

Taken as a whole, this report presents a statistically robust picture of Burton's urban forest in 2016. There is, however, potential that any one of the strata may have an under or over-representation of the number of trees or species, age class, etc., due to the limited amount of data collected at the stratum-level.

In particular, the least deprived area covers less than 2% of the survey area. As the number of survey plots was proportional to the area of each stratum data is limited for this stratum. Similarly it is likely there will be other species present in Burton which were not identified during the field campaign.

This report should be used as an indication only for generalised information on tree distribution, age and species within any of the individual strata. Where detailed information for an area is required further survey work should be carried out.

i-Tree Eco only quantifies certain benefits of trees, as detailed in this report. Other benefits provided including the effect trees have on noise pollution, their role in reducing building energy consumption and secondary effects of pollutants such as acid rain have not been considered as part of this project.

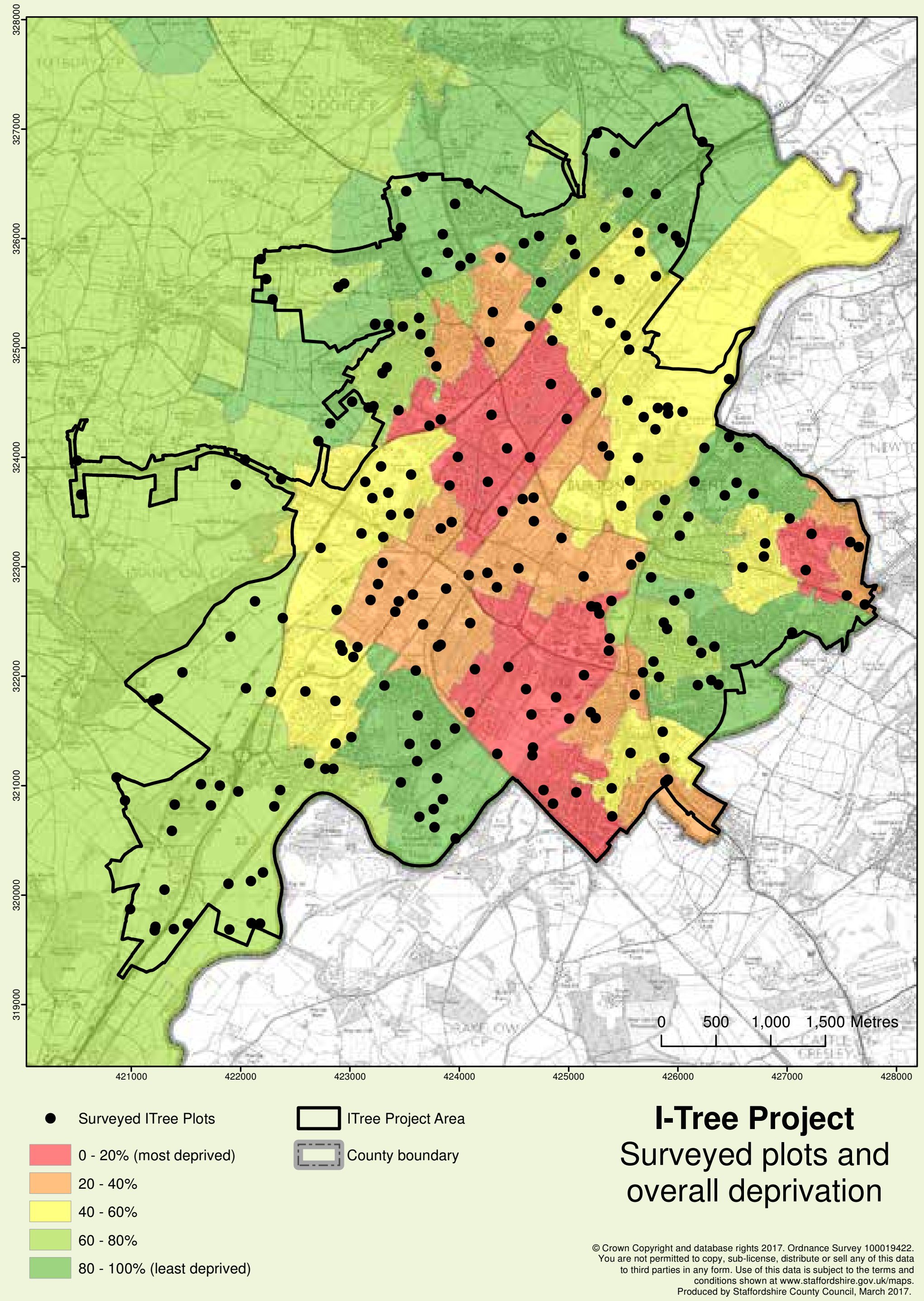


FIGURE 2

THE SURVEY AREA AND SAMPLE PLOTS

RESULTS/ ANALYSIS

It is estimated Burton has a tree cover of 9.4%, equating to a population of 102,400 trees.

Urban forests have a structural and functional value. The structural value is the cost of replacing a tree with a similar tree. The functional value, is a calculation of the variety of environmental functions they can perform.

For Burton these are estimated at:

STRUCTURAL VALUES:

- The cost to replace a tree with a similar tree in the same location is estimated at **£54.2 million.**
- The contribution to the public as an amenity tree is estimated at **£1,126 million.**
- Carbon Storage is the amount of carbon held in the woody part of the vegetation and is estimated at **£1.23 million** (19,800 tonnes).

FUNCTIONAL VALUES:

- Carbon Sequestration is the amount of carbon dioxide removed from the air by plants and is estimated at **£44,800** per year (722 tonnes/year of carbon).
- Avoided Runoff is calculated based on rainfall interception by vegetation. Although tree leaves, branches and bark may intercept rainfall, only rainfall intercepted by leaves is accounted for in the analysis, equating to **£21,700** per year (23,700 m3/year).
- Pollution Removal is calculated using local pollution data and is estimated to be **£48,800** per year (23 tonnes/year).

Note: Costs are correct at the time of analysis (February 2017); valuations are subject to market conditions and may change in the future.

Pollution removal and avoided runoff estimates are reported for trees and shrubs. All other ecosystem services are reported for trees.

THE THREE MOST COMMON SPECIES ARE BEECH, HAWTHORN AND SYCAMORE

These three species account for 33% of the tree population. The top 11 species are summarised in Figure 3 with a full species list included in Appendix I (note the majority of the Beech were identified in one plot and could therefore be showing an over representation of Beech distribution across Burton).

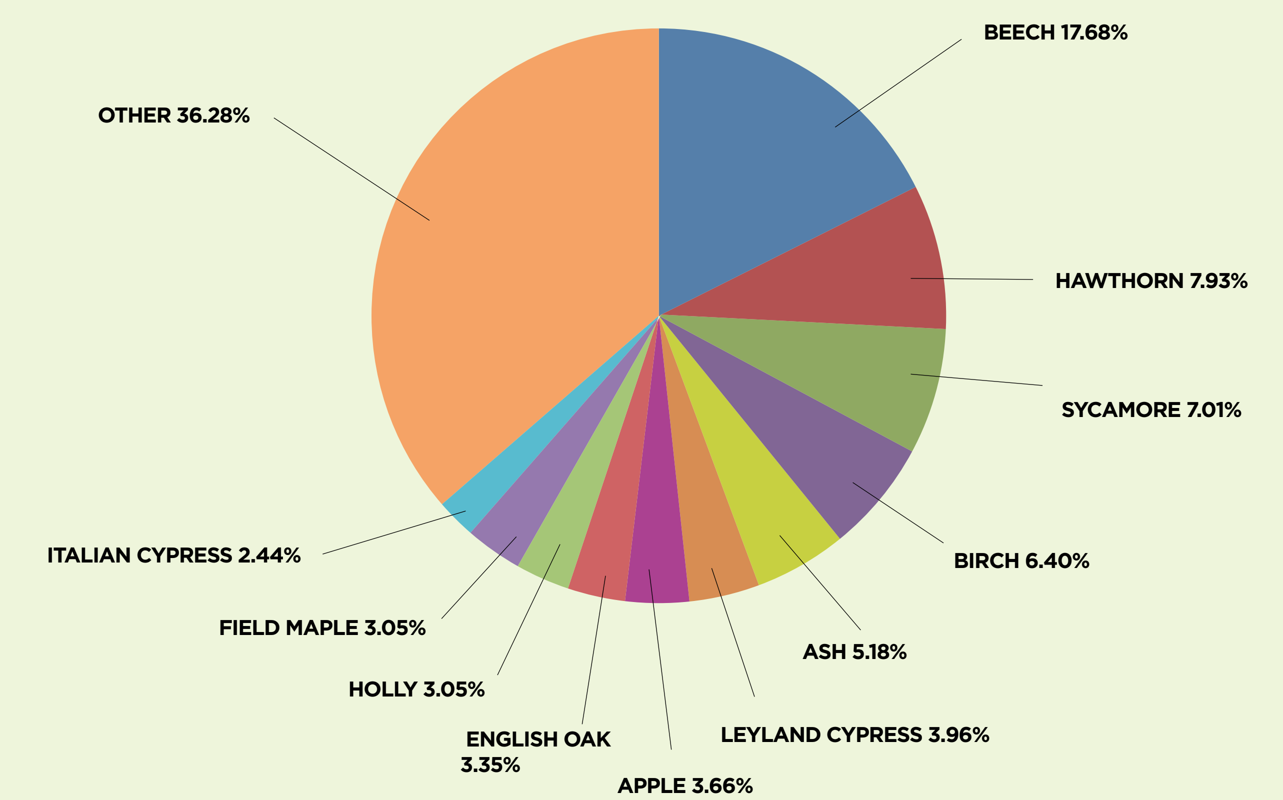


FIGURE 3

SPECIES MIX, SHOWING THE TOP 11 MOST COMMON SPECIES IN BURTON'S URBAN FOREST

Burton is dominated by younger trees with 40% having a diameter at breast height of (DBH) of less than 15 cm and 52% being between 15-50 cm (77% of the population had a DBH of less than 30 cm). This is detailed in Figure 4.

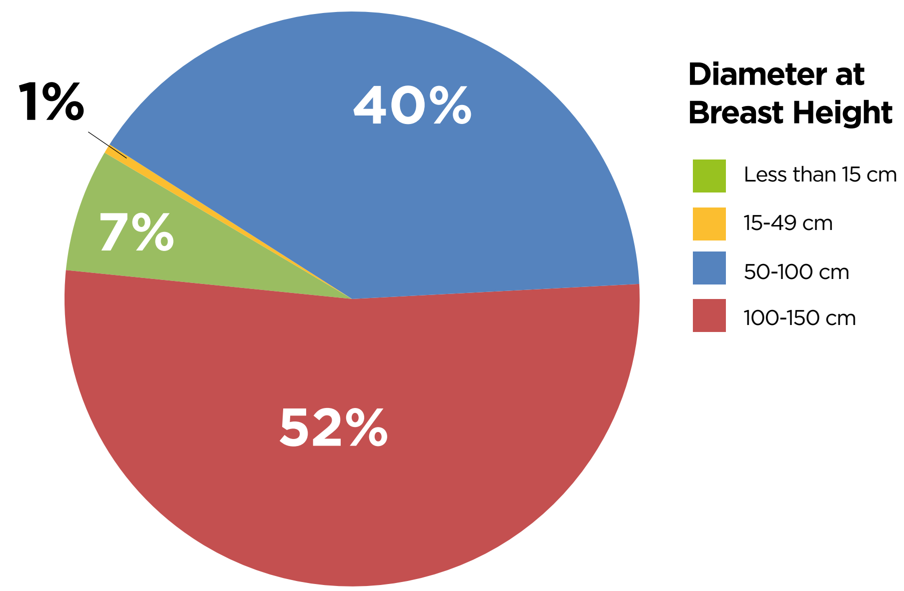


FIGURE 4

DISTRIBUTION OF TREES BY SIZE CLASS (DIAMETER AT BREAST HEIGHT)

The tree population and associated benefits for each of the stratified categories is summarised below and in Tables 1 and 2 and Figures 5, 6 and 7. The 'least deprived area' represents less than 2% of the study area, therefore the data collected in this area is limited and has not been included in the summary.

- Tree density is remarkably similar between the strata, ranging from 34 to 41 trees per ha. Average DBH is small (typically 24 cm) and approximately equal across the strata, as is height – ranging only 8 to 12 m.
- Tree density and average tree height is highest in the 'above average deprivation area'. A consequence of the disproportionately high numbers of common beech reported in this stratum, relative to the other areas (this is due to one of the plots in this stratum being located within a beech plantation).
- The Structural and Functional values are greatest in the 'most deprived area' due to the relatively higher number of large stature trees (oak and sycamore) and trees with a high total leaf area (such as willow spp.) relative to the other strata
- Leaf area per hectare is second highest in the 'average deprivation area'. This area also has the lowest carbon sequestration rate; this is due to the low frequency of large stature long lived trees in this stratum, relative to the size and population distributions of the other strata.
- Carbon storage was second highest in the 'below average deprivation area' although the structural values in terms of carbon sequestration, avoided runoff and pollution removal is lower in comparison to the other stratum. This is due to the relatively low numbers of large stature trees (oak spp., sycamore or beech) relative to the other strata.
- There is no clear correlation between the level of deprivation and any of the urban forest characteristics.

These results emphasise the role that different species and the age structure has in influencing the functional and structural values provided. In particular, i-Tree Eco demonstrates that it is both size (stature) of a tree species and the relative contribution of each species to the total population of the urban forest that are critical in the current delivery of ecosystem services. I-Tree Eco terms this 'Importance Value'. The importance value (IV) of each of the tree species recorded in the field campaign is present in Appendix I.

An i-Tree Eco study presents a snapshot-in-time of an urban forest – its composition and condition etc. at the time of the survey. This is especially true of IV which highlights those species of greatest importance now.

IV is a useful tool in risk analysis, for example to help understand the impact of a particular pest or disease. It can also be useful in planning.

A species with a high IV and a high percentage presence in the urban forest may be important now but is less important, especially in the longer term, than a species with a high IV for a relatively low population. Planting more of the latter will more substantially bolster ecosystem service delivery. Oak, lime and beech are frequently represented in the most valuable trees in an urban forest (as reported in other i-Tree Eco surveys), however this pattern does not bear out in Burton with beech, sycamore and ash have the highest IV values.

TABLE 1

TREE DENSITY AND AVERAGE FOR EACH OF THE FOUR PROJECT STRATA

Stratum	Tree Density per ha	Average DBH (cm)	Average Height (m)
Below average deprivation	35	24	9
Average deprivation	34	18	8
Above average deprivation	41	24	12
Most deprived	37	24	9

TABLE 2

LEAF AREA, AND CARBON STORAGE SEQUESTRATION FOR EACH OF THE FOUR PROJECT STRATA

Stratum	Leaf Area per ha	Carbon Storage (kg/ha)	Carbon Sequestration (kg/ha/year)	Avoided Runoff (m3/ha/year)	Pollution Removal (kg/ha/ year)
Below average deprivation	3908	7084	274	7	4
Average deprivation	4075	6131	200	9	5
Above average deprivation	3355	5582	273	8.5	4.5
Most deprived	4298	12276	327	9	5

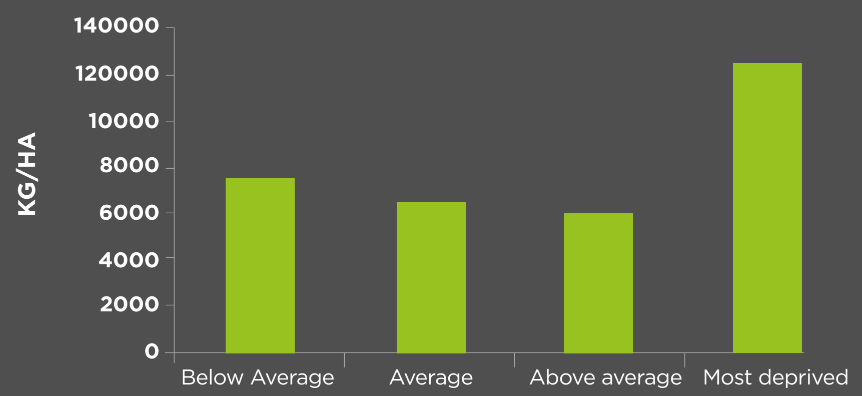


FIGURE 5

CARBON STORAGE

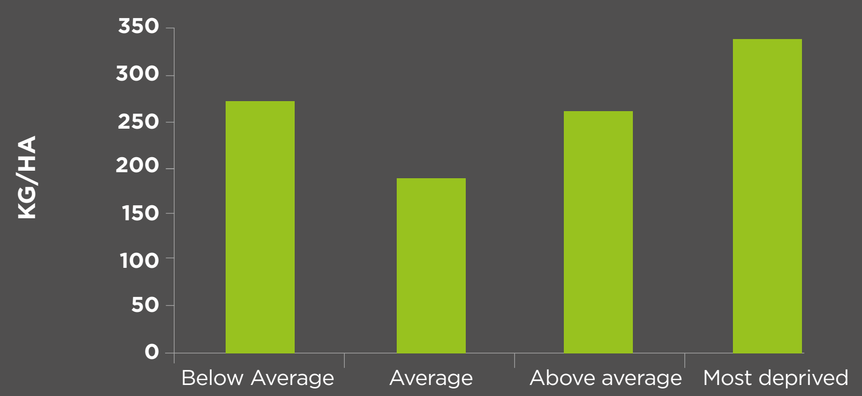


FIGURE 6

ANNUAL CARBON SEQUESTRATION

According to the CAVAT Quick Method valuation technique, the amenity value of Burton's urban forest is valued at £1,126 million. This figure is distinct to the Council of Tree and Landscape Appraisers (CTLA) valuation of £54.2 million.

The CTLA estimation is the cost to replace that tree with another structurally identical in that location, taking into consideration the species, condition and location factors. Unlike CTLA, CAVAT values trees based upon their contribution to the public as an amenity tree.

CAVAT addresses worth more so than value, it reveals trees as assets to be managed and maintained to grow their portfolio of worth. Figure 8 shows the ten most valuable trees in terms of amenity (CAVAT value) revealing sycamore, beech and willow have the highest value, reflecting the predominance of mature sycamore, beech and willow across the sample area.

The land-uses containing the highest proportion of trees according to amenity valuation are park, residential and vacant (Figure 9). The size of Burton's tree population on vacant land, therefore, represents a valuable asset that should be appropriately protected in planning policy and considered in planning decisions, where possible.

The CAVAT valuation also reveals the importance in terms of amenity valuation of public trees in parks, cemeteries and around multi-family residential/multiple separate housing unit areas and, therefore, the need to appropriate fund the management of this resource.

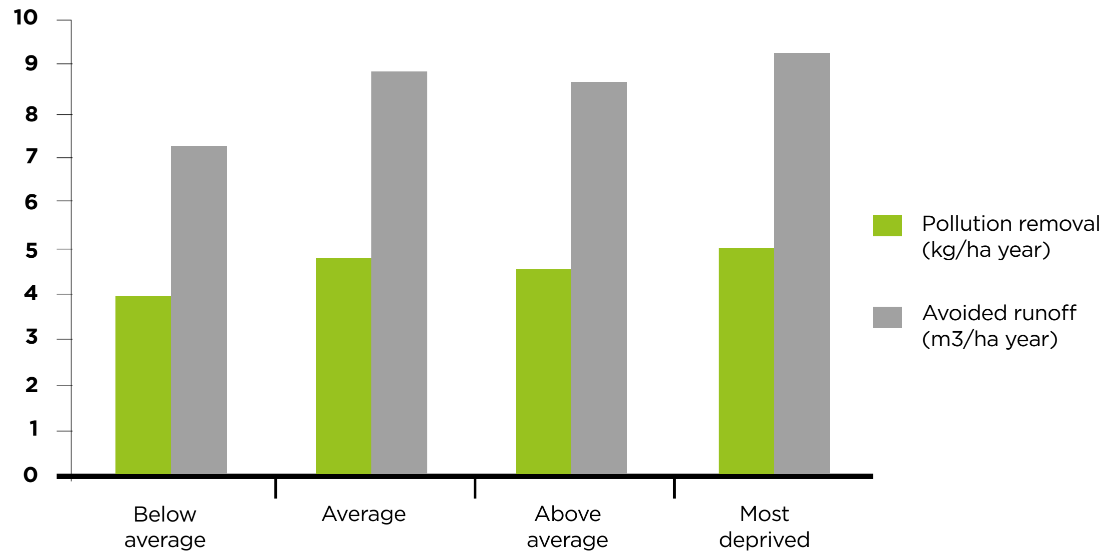


FIGURE 7

ANNUAL AIR POLLUTION REMOVAL AND AVOIDED RAINWATER RUNOFF IN EACH OF THE DEPRIVATION CLASSES

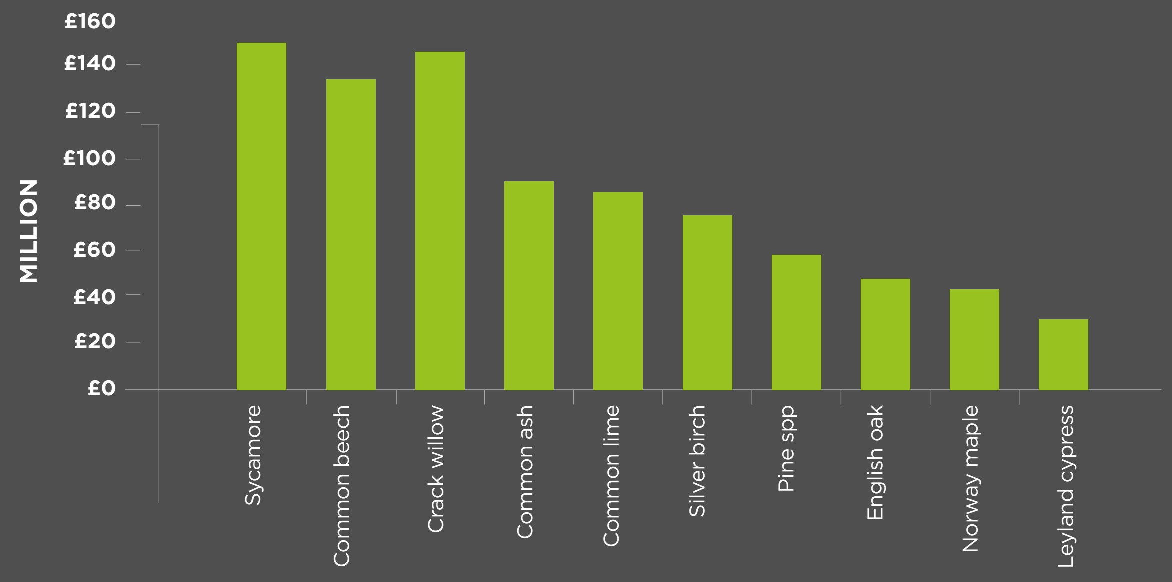


FIGURE 8
CAVAT VALUATION OF BURTON'S URBAN FOREST, BY SPECIES

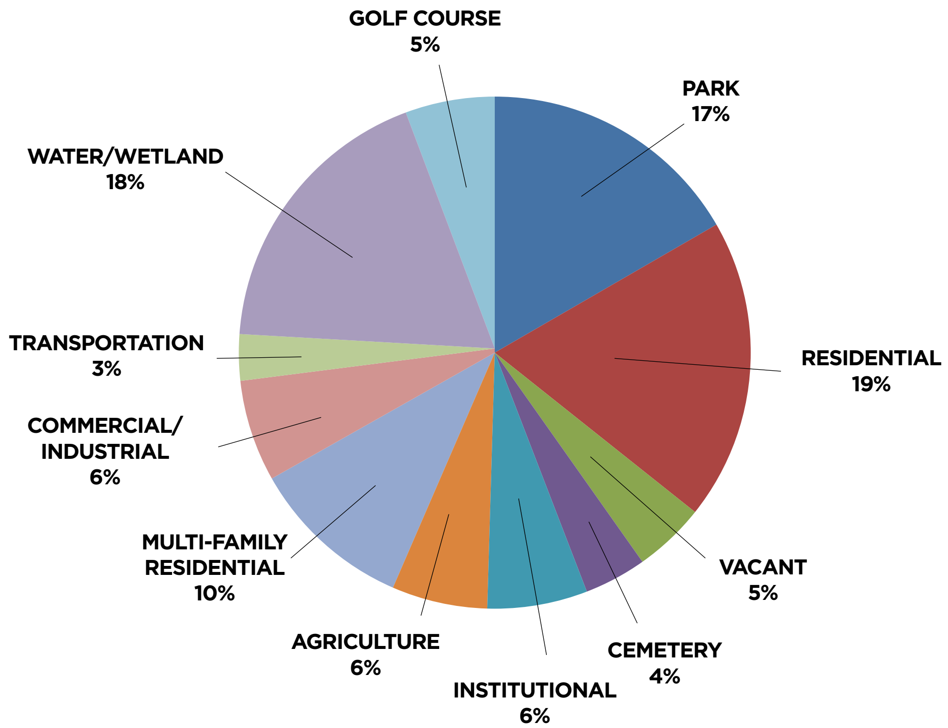


FIGURE 9
LAND-USES WHERE THE TREES ARE LOCATED

CONCLUSIONS AND LESSONS LEARNT

The study has provided a greater understanding of Burton's urban forest and the role it plays in maintaining a healthy environment for residents, visitors and wildlife. The relatively low numbers of trees identified during the survey indicates that there is considerable capacity to expand Burton's urban forest and the role this can have in environmental, social and economic improvement.

This project has been unique in applying a quantitative value for trees and linking this with environmental, health and deprivation data.

This data provides useful baseline information to direct planting to those areas where communities are likely to see the greatest benefit not only in terms of health and amenity, but also the potential positive outcomes in terms of reduction of crime and of investment.

Allocating quantitative values to tree and shrub populations are useful metrics to show the value of the urban forest. These values cannot be considered in isolation as the values have been applied considering a wide range of variables. Although some trees are better than others for the provision of some services, it is still important to maintain a diverse urban forest.

For example some of the best tree species for pollution and runoff reduction generally have a large leaf surface area. Although these species may be best for improving air quality and holding rainfall in the canopy a broad range of species should be considered to provide resilience to threats from disease and be suitable for the site aspect, soil and amenity.

Not all elements can have a quantitative value applied, this does not mean they are any less important when considering the right tree for the right place.

THE WAY FORWARD

The i-Tree survey gives us a snapshot of Burton's urban forest in 2016, quantifying the benefits it currently offers to residents and the environment. It has identified many positive attributes but has also identified some key issues that need to be addressed. This section provides a management strategy to identify how the urban forest can be enhanced to maximise the benefits it delivers.

The East Staffordshire Local Plan (2012 – 2031) sets a 20-year vision for Burton which includes:

> *"Burton upon Trent: will be a positive and ambitious town, which has developed its sub regional status as an economic, retail, leisure and cultural centre… Burton upon Trent will be recognised nationally as the "Capital" of The National Forest, with a high quality and diverse green infrastructure network providing environmental, biodiversity, health, and sustainable transport opportunities…"*

This management strategy explores the role that the urban forest can play in achieving this vision.

AIMS

The following aims are based on the outcomes of the i-Tree survey, additional evidence from national datasets and relevant local strategies:

1. **Increase the overall tree cover**
2. **Develop a more diverse age structure to address the dominance of younger trees**
3. **Improve the species diversity of the urban forest to increase resilience**
4. **Enhance biodiversity**
5. **Enhance the sense of place and amenity value**
6. **Increase the contribution of the urban forest to public health outcomes**
7. **Increase the contribution of the urban forest to the local economy and maximise opportunities from new developments**
8. **Increase the contribution of the urban forest to climate change resilience and mitigation**

Each aim lists objectives to achieve the specified aim, though many also have the capacity to contribute to multiple aims. Appendix II lists the objectives and highlights the range of aims each objective can contribute to achieving.

AIM 1
INCREASE THE OVERALL TREE COVER

OBJECTIVE: Increase tree cover by creating at least 30 hectares of new planting

The study indicates that the area has a relatively low tree cover. This is recorded as being between 34 to 41 trees per hectare with 9.4% canopy cover. Comparing Burton with other major i-Tree studies carried out in the UK, Burton ranks the lowest, see Table 3.

Comparative study area in the UK	Percentage canopy cover
Edinburgh	17%
Wrexham	17%
Glasgow	15%
London	14%
Torbay	11.8%
Burton Upon Trent	9.4%

TABLE 3
CANOPY COVER COMPARISON FROM OTHER UK TOWNS AND CITIES

Increasing tree cover will help to achieve all the aims of this management strategy and is therefore fundamental.

The i-Tree survey indicated that there was 25% plantable space consistent across all strata. This means that some 712 hectares may be available for planting, a large proportion on private land. This estimate has been based on the survey data, which represents less than 1% of the study area and also has not taken into account whether there are any other constraints. Planting proposals should be informed by existing ecological and landscape quality together with any other potential constraints. This includes pests and diseases, proximity to drainage systems, potential impacts on natural water flow, historical features and maintenance requirements. The estimated plantable area should therefore be taken as an indication only.

Recent research by Forest Research is recommending that towns and cities should set a tree cover target of at least 20% (15% for coastal towns) (Doick et al 2017). The average tree cover from the studies shown in Table 3 is 14%. Topography and city layout can have a large influence on tree cover and an aspirational target of 20% for Burton is likely to be extremely challenging.

This is particularly the case as many of the areas that would most benefit from additional tree cover are heavily urbanised, meaning that planting will be costly and difficult. While 20% cover may therefore be a long term aspiration, for the next five years a modest target of a 1% increase is proposed. This recognises the work required in preparation ahead of any planting and would still achieve significant ecosystem benefits.

The 1% target equates to 30 hectares of land to be planted, to be achieved through a combination of planting whips or standards appropriate to the area. It is recommended the target is reviewed in 5 years with the potential of increasing it when a greater understanding of potential planting areas has been established.

AIM 2
DEVELOP A MORE DIVERSE AGE STRUCTURE TO ADDRESS THE DOMINANCE OF YOUNGER TREES

OBJECTIVES:

i. Survey and create an inventory of veteran trees
ii. Review the use of Tree Preservation Orders to ensure that stature trees are protected as appropriate
iii. Encourage a proportion of all new species selected for planting to have the genetic capacity to grow into a large mature tree
iv. Encourage active management of mature trees

An urban forest needs enough large and mature trees to deliver the widest possible range of environmental benefits in urban areas and enough trees in a number of younger age classes to replace these mature trees as they die.

The i-Tree study indicated that 77% of the tree population of Burton has a DBH (diameter at breast height) of less than 30cm, with only 7.5% with a DBH above 50cm. Research suggests that the ideal DBH range for street and park tree populations should be approximately 40% with a DBH of 0-20cm, 30% with a DBH of 20-40cm, 20% with a DBH of 40-60cm and 10% with a DBH of greater than 60cm (Richards 1983). Figure 10 illustrates that there is some variance across the deprivation classes, although all areas are dominated by younger/smaller trees. It is however acknowledged that the survey included private gardens in addition to street trees and public places and therefore a higher percentage of smaller trees are likely to be experienced.

The species of tree within each age class is also an important consideration for maintaining a healthy diverse age structure. For example an oak with a DBH of 50cm may only be middle aged whereas faster growing species such as willow and poplar may be approaching the end of their safe and useful life expectancy. The largest trees in Burton (i.e. those with a DBH in excess of 50cm) are made up of a mix of slow growing long lived trees and faster growing shorter living species which is summarised in Figure 11.

It is obvious that the imbalance in the Burton age distribution cannot be corrected quickly and that conserving Burton's existing large trees is of paramount importance wherever possible. Identifying veteran trees across the town is therefore a critical step, plus exploring measures for their appropriate protection and management.

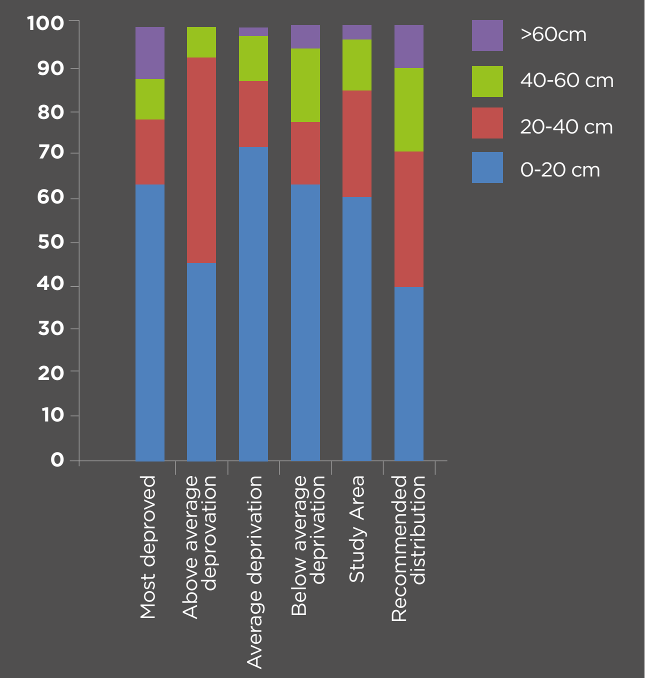


FIGURE 10
DBH OF TREES BY DEPRIVATION CLASS

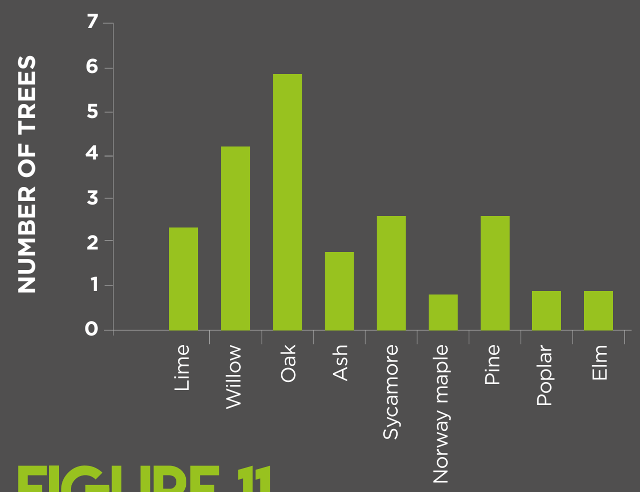


FIGURE 11
SPECIES IN THE STUDY AREA WITH A DBH IN EXCESS OF 50CM

AIM 3
IMPROVE THE SPECIES DIVERSITY OF THE URBAN FOREST TO INCREASE RESILIENCE

OBJECTIVES:

i. Design for species diversity in line with good practice for resilience

ii. Purchase British grown trees where possible. Any imported species planted should have been appropriately quarantined

It is important to build resilience into our urban forests

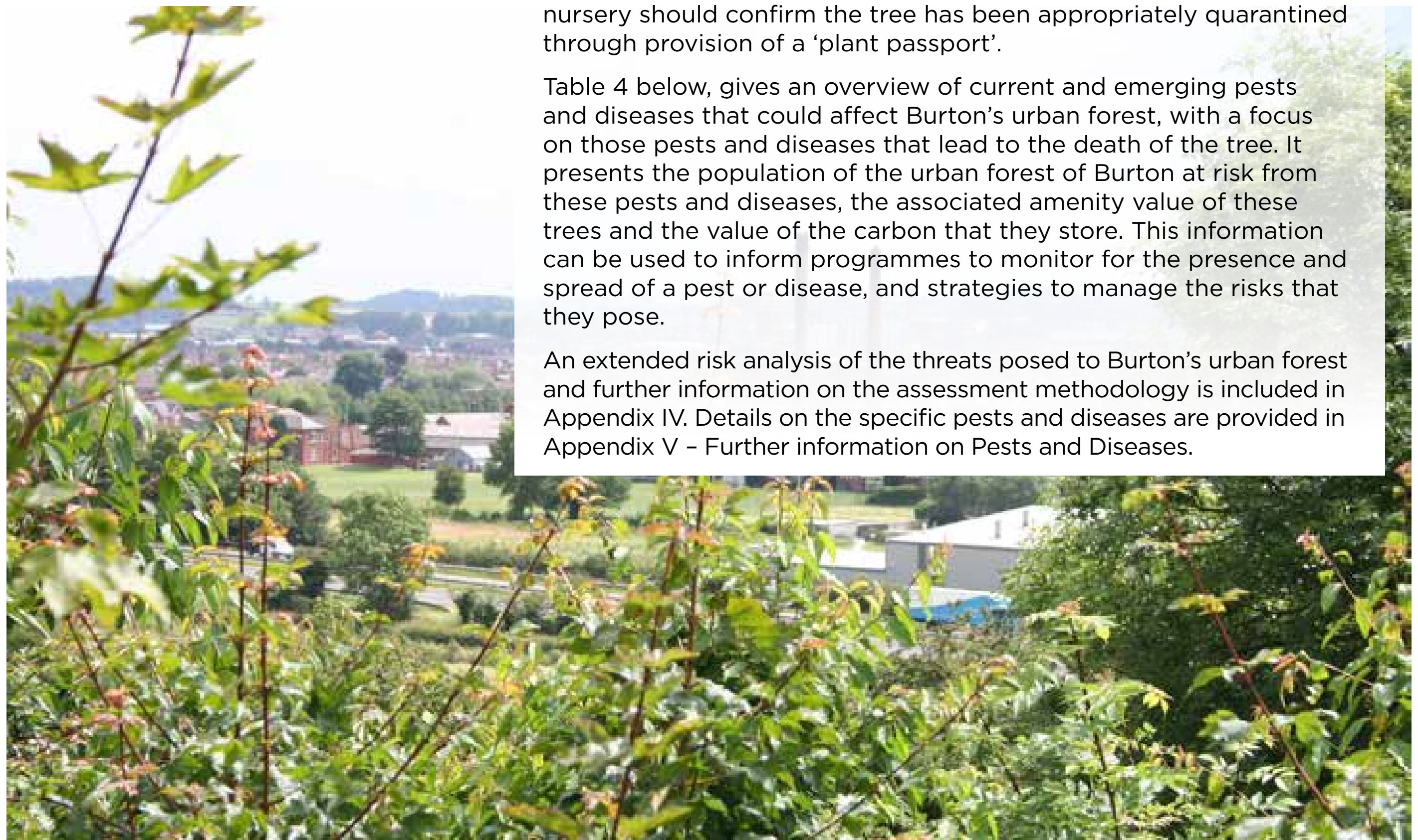
British grown tree stock should be purchased where possible

Climate change and pests and diseases present an increasing threat to the urban forest and measures to increase resilience must form part of this strategy. A number of diseases are already present in the UK threatening tree populations. For example, Dutch elm disease was widespread in the UK and has almost killed off the native English elm population. Protecting the urban forest as a whole against these threats can be partially achieved by ensuring a high diversity of tree species. Suggested good practice for urban forests to be resilient to pests and diseases is that no species should exceed 10% of the population, no single genus should comprise more than 20% and no single family should contain more than 30% (Clark et al). Whilst the survey indicates 18% of the population is beech this could be an overestimation due to a plantation with a large number of beech being identified on a single plot. No other species exceeded the 10% threshold.

With increased importation of wood and trees in addition to a climate that is becoming more amenable to the pests and diseases that can travel into the UK on these imports, it is important to build resilience into our urban forests. Threats present and those not yet present in the UK, such as Asian longhorn beetle, could potentially devastate a diverse range of urban trees. UK-wide initiatives such as plant health restrictions are designed to combat these threats, but many pests are difficult to detect (Forestry Commission 2014), vigilance is key. Monitoring urban trees for signs of pests and diseases helps ensure a fast response to eradicate pests before they become established or widespread. British grown tree stock should be purchased where possible. If purchasing imported trees the nursery should confirm the tree has been appropriately quarantined through provision of a 'plant passport'.

Table 4 below, gives an overview of current and emerging pests and diseases that could affect Burton's urban forest, with a focus on those pests and diseases that lead to the death of the tree. It presents the population of the urban forest of Burton at risk from these pests and diseases, the associated amenity value of these trees and the value of the carbon that they store. This information can be used to inform programmes to monitor for the presence and spread of a pest or disease, and strategies to manage the risks that they pose.

An extended risk analysis of the threats posed to Burton's urban forest and further information on the assessment methodology is included in Appendix IV. Details on the specific pests and diseases are provided in Appendix V - Further information on Pests and Diseases.



Pest/Pathogen	Species affected	Prevalence in the UK	Prevalence in Midlands	Risk of spreading to Midlands	Population at risk (%)	CAVAT value of sampled trees (£)	Stored carbon value trees(£)
Chalara dieback of ash	*Fraxinus excelsior, F. angustifolia*	Cases across the UK	Confirmed cases in Midlands	High - already present	5.2%	115,911	78,876
Dothistroma red band needle blight	Pine species	Significant disease in North of UK	Confirmed in Cannock Forest	High - already present	0.6%	75,085	38,669
Giant polypore	*Quercus spp., Fagus spp., Aesculus spp., Sorbus spp.* and *Prunus spp*	Common in urban areas	Common in urban areas	High - already present	28.7%	309,905	440,200
Asian longhorn beetle	Many broadleaf species (see Appendix IV)	None (previous outbreaks contained)	None	Medium risk - climate may be suitable	61.0%	786,579	576,178
Gypsy Moth	*Primarily Quercus sp., secondarily Carpinus betulus, F. sylvatica, C. sativa, B. pendula* and *Populus sp.*	London, Aylesbury and Dorset	None	Medium risk - slow spreading	30.5%	419,246	516,200
Phytophthora kernoviae	*F. sylvatica, Ilex aquifolium, Q. robur, Q. ilex*	Mainly SW England and Wales	None	Medium risk	24.7%	280,515	415,512
Phytophthora ramorum	*Q. cerris, Q. rubra, Q. ilex, F. sylvatica, C. sativa, Larix decidua, L. x eurolepsis*	Many UK sites, particularly in S Wales and SW England	Some cases reported in the Midland	High - already present	21.6%	185,823	144,355
Emerald ash borer	*F. excelsior, F. angustifolia*	None	None	Medium risk (imported wood)	5.2%	115,911	78,876

TABLE 4

SUMMARY TABLE OF THE RISKS OF CURRENT AND EMERGING PESTS AND DISEASES TO BURTON'S URBAN TREES, WITH A FOCUS ON THOSE TREE SPECIES MOST VULNERABLE.

For an urban forest to be resilient to pests, diseases and climate change a diverse range of species needs to be present. This diversity has two main components, the number of species present and the genetic diversity within the population as a whole.

50 different species were recorded in Burton which is considered low in comparison to the other i-Tree studies. For example Torbay and London (which also had lower canopy cover in comparison to the other UK studies) recorded 102 and 126 species respectively.

While there has traditionally been a focus on native species of local provenance, there is a growing consideration in the light of climate change and increasing pressures from pests and diseases that non-native species may also have a role to play, particularly in urban forests. Native trees are more likely to support a greater amount of biodiversity, however to link to other aims in the strategy non-native trees with a capacity to become large trees at maturity, offering a wider range of ecosystem services could be suitable for some situations.

It should also be recognised when selecting species that nursery production methods will mean with some species that all progeny are clonal selections and therefore genetically identical. For example all Sorbus sheerwater seedlings will be grafted onto Sorbus aucuparia and therefore genetically identical.

AIM 4
ENHANCE BIODIVERSITY

OBJECTIVES:

i. New planting schemes to include speicies of high biodiversity value

ii. Target new planting to enhance ecological networks

For an urban forest to be resilient to pests, diseases and climate change a diverse range of species needs to be present.

To enhance biodiversity through the urban forest there are two considerations – the wildlife individual trees support, and the contribution the urban forest makes to ecological connectivity.

Trees vary in the number of species they support. Large, mature trees offer unique ecological roles not offered by small, younger trees, and species type can have a large influence on the number of wildlife species supported. For example, a mature oak can host over 420 species of invertebrates, which are a valuable food source to birds and mammals.

Figure 12 provides a summary of trees which support a high number of invertebrates. Selecting trees which support high biodiversity will increase the urban forest's contribution to nature conservation in Burton. A full list of species which support high numbers of invertebrates is provided in Appendix VI.

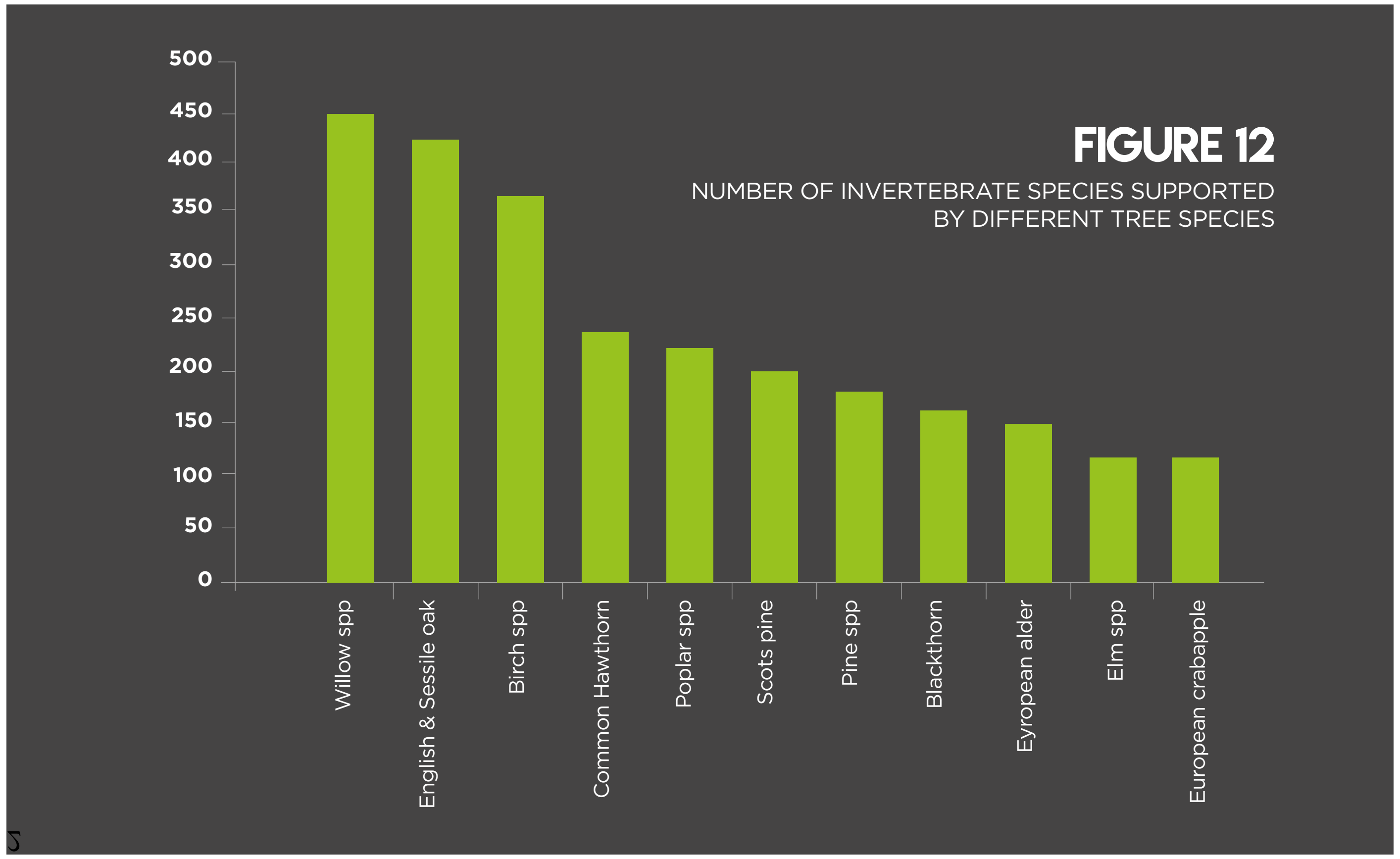


FIGURE 12
NUMBER OF INVERTEBRATE SPECIES SUPPORTED BY DIFFERENT TREE SPECIES

As well as considering species, it is important to consider the key role the urban forest can play in creating ecological links and networks across the town.

Ecological links and networks are vital to create 'stepping stones' for wildlife to move through the area, ensuring that populations do not become isolated and therefore vulnerable.

The dense nature of built development in Burton means that, aside from the river and canal there is low ecological connectivity in the town.

A string of Sites of Biological Importance (SBIs - Local Wildlife Sites of county value) indicate the importance of the River Trent floodplain through Burton. Scalpcliffe Hill Local Nature Reserve and SBI supports a small area of ancient woodland, species-rich grassland and scattered mature trees, including recently planted woodland. The Nature Reserve is connected to the Trent Valley Washlands and to further greenspace but the greenspace corridor does not link to open countryside.

The Trent and Mersey Canal represents another north/south corridor. Associated with the canal are small areas of scrub and grassland but it is mainly tightly surrounded by built development. These green corridors support such species as bats, otters, kingfishers, snipe, skylarks and rare insect species.

Winshill and Stapenhill, to the east of the Trent, support a network of open spaces of various kinds, including sports pitches, cemeteries, allotments and informal greenspace. There is a good proportion of mature gardens with tree cover. The western side of the town is more densely developed with green spaces being smaller, more isolated and with less tree cover.

The East Staffordshire Local Plan Planning for Change Green Infrastructure Study Update 2013 includes a Vision for 2021 that:

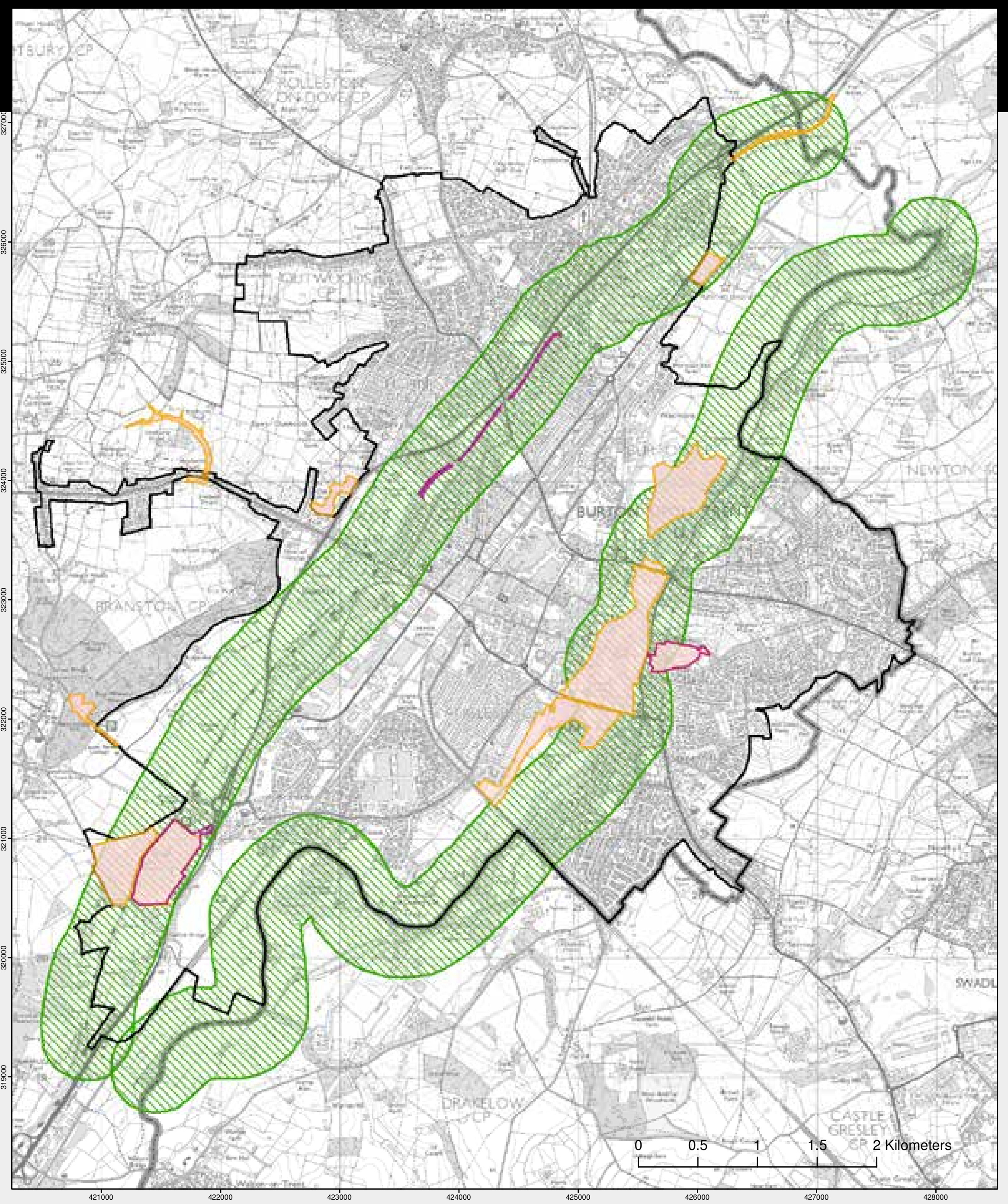
Burton upon Trent will be an attractive, green town with large areas of developing urban woodland, easily recognisable as the capital of The National Forest. This reputation, along with the realisation of the benefits provided by the River Trent, will make it a very desirable place to live and work with large areas of well-managed accessible woodland within cycling distance of the town.

The Green Infrastructure Study recognises the paucity of tree cover in Burton and the scope to improve ecological value. It recommends a Multi-Functional Parks Project to introduce features such as trees, ponds, rough grassland areas, interpretation boards and land art to provide a range of values for wildlife and community. There is potential for measures carried out under a strategic approach such as this to be funded by Community Infrastructure Levy (CIL) or s106 payments from new development.

Figure 13 shows the green corridors where priority should be given to providing greater linkages for wildlife. Within these and elsewhere consideration of existing biodiversity value is required before planting is planned. Information can be obtained from Staffordshire Ecological Record, Staffordshire Wildlife Trust, Staffordshire County Council Environmental Advice Team and Burton Conservation Volunteers.

FIGURE 13

GREEN CORRIDORS AND IMPORTANT WILDLIFE AREAS



Local Nature Reserve

Site of Biological Importance

Key green corridors

ITree Project Area

County boundary

I-Tree Project

Areas of Biodiversity

AIM 5

ENHANCE THE SENSE OF PLACE AND AMENITY VALUE

OBJECTIVES:

i. Locate planting to improve green spaces
ii. Respect the landscape character in planting design and species selection
iii. Use planting to buffer new development to maintain the wider landscape qualities
iv. Enhance the sense of place, particularly in more deprived parts of the town through increasing tree cover.

Green spaces have also been shown to reduce crime levels particularly in deprived communities

The landscape of Burton is characterised by flat topography with visual links of the landform and land uses of surrounding areas. Typically the landscape is characterised by trees associated with waterside planting, along the river and dyke courses. The predominantly pastoral farming on the floodplain gives way to areas of arable cropping on higher ground. Hedgerow pattern varies from irregular to small areas with straight hedgerows and a regular pattern, with variable woodland cover.

The landscape of the town is visually contained by built development which tends to occur adjacent to the floodplain and this, along with pressures relating to development; considerably change the character of the landscape.

The town contains several mature woodland blocks, these include the ancient Scalpley Wood, which forms part of Scalpcliffe Hill Local Nature Reserve and Waterloo Clump.

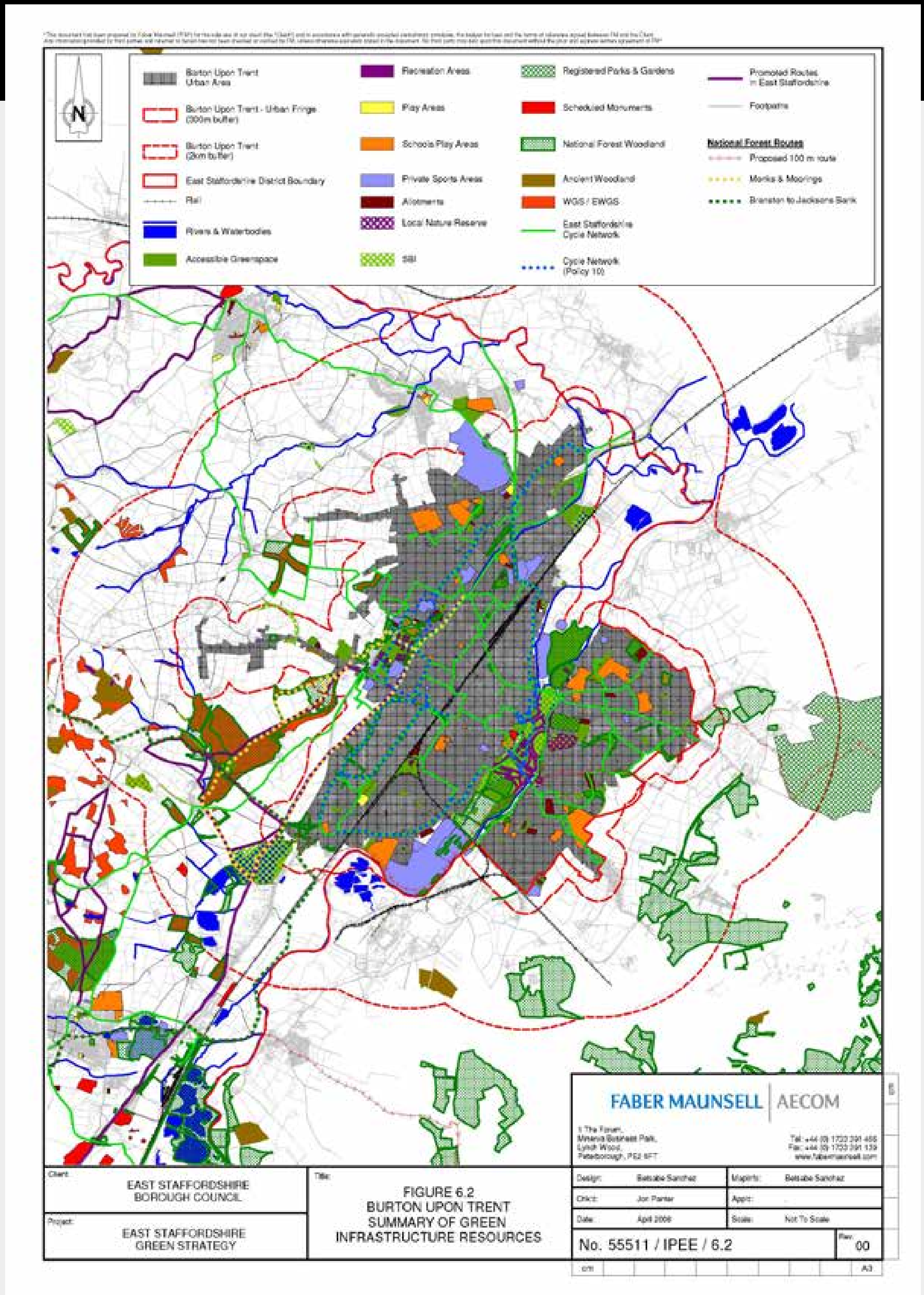
The CAVAT valuation of £1,126 million for Burton reveals the importance of public trees in terms of amenity valuation in parks, cemeteries and public spaces.

The National Forest Company and partner organisations are increasing the town's tree cover through the planting of areas of former grassland or agricultural land and the effects of this planting will become more noticeable as the trees mature, in particular in and adjacent to the Trent corridor where significant areas of new woodland have been planted.

Green spaces have also been shown to reduce crime levels particularly in deprived communities (Bell et al.). The East Staffordshire Local Plan Green Infrastructure Study identifies key green spaces, which is summarised in Figure 14.

Woodland planting has a key role to play and priority should be given to identifying suitable areas for planting within the identified key green spaces and consideration given to species selection in character with the landscape such as black poplars within the river floodplain.

FIGURE 14
BURTON UPON TRENT GREEN SPACES



AIM 6
INCREASE THE CONTRIBUTION OF THE URBAN FOREST TO PUBLIC HEALTH OUTCOMES

OBJECTIVES:

i. Increase 'greenness' in residential areas to improve mental health and wellbeing

ii. Seek to plant trees which have the greatest capacity to capture pollution in the urban centre where air quality is poorest

iii. Explore initiatives to encourage residents to increase tree and shrub cover in gardens

In Burton it is estimated that each year trees and shrubs remove 23 tonnes of air pollution

Urban forests can bring a range of benefits for physical and mental health and wellbeing by reducing pollution levels, buffering noise and providing green spaces for exercise. These can all assist in reducing stress, anxiety and mental fatigue and providing cleaner air.

Research has found that particulate levels on tree-lined streets can be up to 60% lower than those without trees. Street trees have also been associated with a lower prevalence of asthma in children (Lovasi et al.). A study which classified the population of England on the basis of income deprivation and exposure to green space found that health inequalities related to income deprivation were lower in populations living in the greenest areas. It also concluded socio-economic inequalities were reduced in neighbourhoods with good access to greenspace (Mitchell et al.)

In Burton it is estimated that each year trees and shrubs remove 23 tonnes of air pollution (ozone, carbon monoxide, nitrogen dioxide, sulphur dioxide and particulate matter less than 2.5 microns (PM2.5). Despite this, air pollution levels remain high in and around the town centre as shown in Figures 15 and 16 which illustrate the levels of nitrous oxides and PM 2.5 in Burton. Planting in the areas of highest pollution should be considered a priority where improving air quality is the primary aim.

Trees with a large leaf area achieve the highest pollution capture. A large total leaf surface area can occur because a species has a dense canopy or because the leaf surface is 'rough' (lots of ridges or hairs) (Nature Conservancy). Mature willow, oak, sycamore and ash currently provide the greatest pollution capture for Burton.

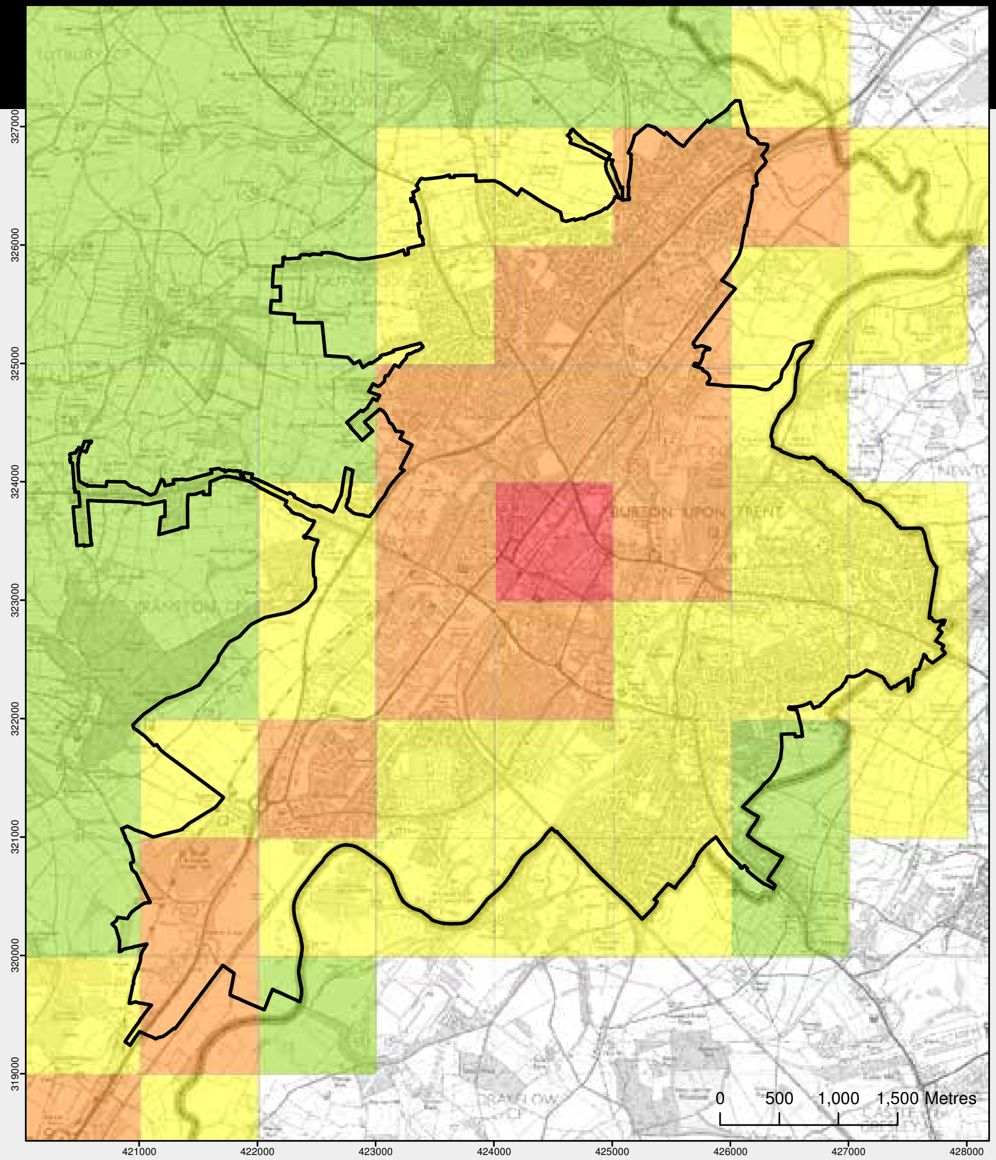
Protecting buildings from harsh weather conditions can improve living conditions and help keep people healthier throughout the year. Trees can play a part an important part by controlling the temperature of buildings through providing summer shading and protection from wind in the winter.

The benefits trees can deliver for human health are outlined above. The greatest benefits are always associated with the largest trees but it is the population as a whole which delivers the full range of benefits. It should also be noted whilst evergreen trees generally have lower annual pollution removal in comparison to some deciduous species, they do remove pollution all year round when deciduous trees are not in leaf.

The density of planting can also be important in high pollution areas. In addition to capturing pollution trees can reduce air circulation, trapping pollution in and under the canopy. Care should therefore be taking when planting trees near major emission sources to ensure enough spacing between tree canopies to allow wind flow between trees (Nature Conservancy).

FIGURE 15

NITROUS OXIDES LEVELS IN BURTON

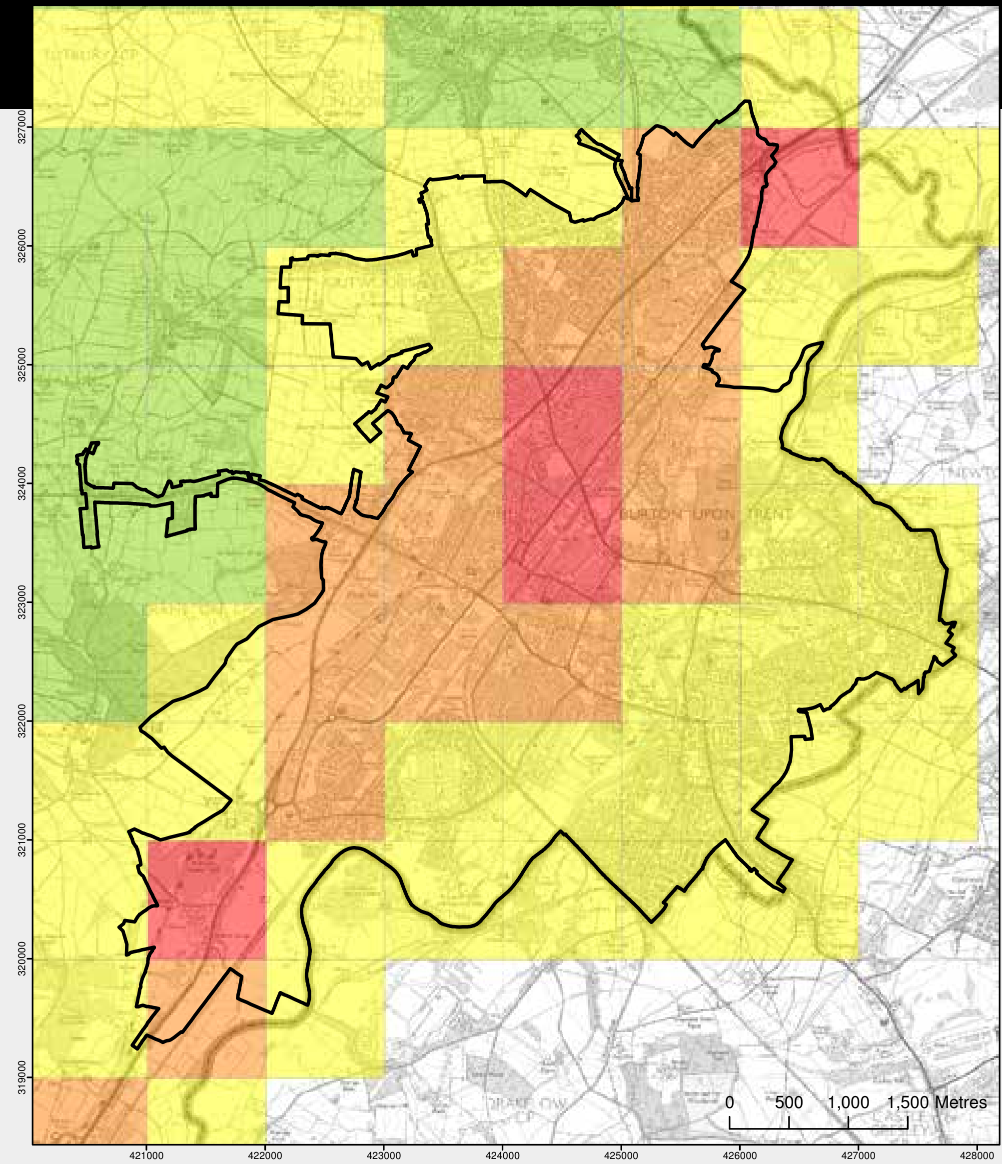


I-Tree Project
Nitrogen Oxides
background concentration.
Annual mean (µg m-3 as NO2) 2012

The annual mean is the average concentration of a pollutant measured over one year. Nitrogen dioxide has a variety of environmental and health impacts. It is a respiratory irritant which may exacerbate asthma and possibly increase susceptibility to infections. The UK meets the 2010 ceilings for emissions in EU and international legislation to reduce emissions of nitrogen oxides. The revised Gothenburg Protocol requires the UK to reduce nitrogen oxide

FIGURE 16

PM 2.5 LEVELS IN BURTON



I-Tree Project
PM2.5 background concentration.
Annual mean (µg m-3) 2012

The annual mean is the average concentration of a pollutant measured over one year. Airborne PM includes a wide range of particle sizes and different chemical constituents. It consists of both primary components, which are emitted directly into the atmosphere, and secondary components, which are formed within the atmosphere as a result of chemical reactions. Of greatest concern to public health are the particles small enough to be inhaled into the deepest parts of the lung. The revised Gothenburg Protocol requires the UK to reduce emissions of PM2.5 by 30 per cent compared to 2005 emissions by 2020.

AIM 7
INCREASE THE CONTRIBUTION OF THE URBAN FOREST TO THE LOCAL ECONOMY AND MAXIMISE OPPORTUNITIES FROM NEW DEVELOPMENTS

OBJECTIVES:

i. Ensure that all development proposals take into consideration tree cover by retention of existing trees and mitigation planting.
ii. Incorporate planting of trees capable of becoming larger mature specimens into new developments where appropriate
iii. Prepare a planting guide for new developments
iv. Support the regeneration and improvement of areas through amenity planting

The construction of new homes should also be regarded as an opportunity to incorporate suitable planting schemes

Urban forests can make areas more attractive places to live and as such can contribute to the urban economy by attracting inward investment. Places landscaped with trees have been shown to increase the value of properties (Cabe). Educational and business outcomes can also improve as people concentrate better after spending time in nature, or even looking at scenes of nature (Forestry and Woodlands Advisory Committee).

Research in Glasgow showed regeneration using green infrastructure of a run-down area (negative aesthetics and perception) caused house prices to increase by 111% (Gen Consulting). Figure 17 identifies the most deprived areas. Planting in these areas could contribute to the multiple benefits urban forests can have in regenerating deprived communities.

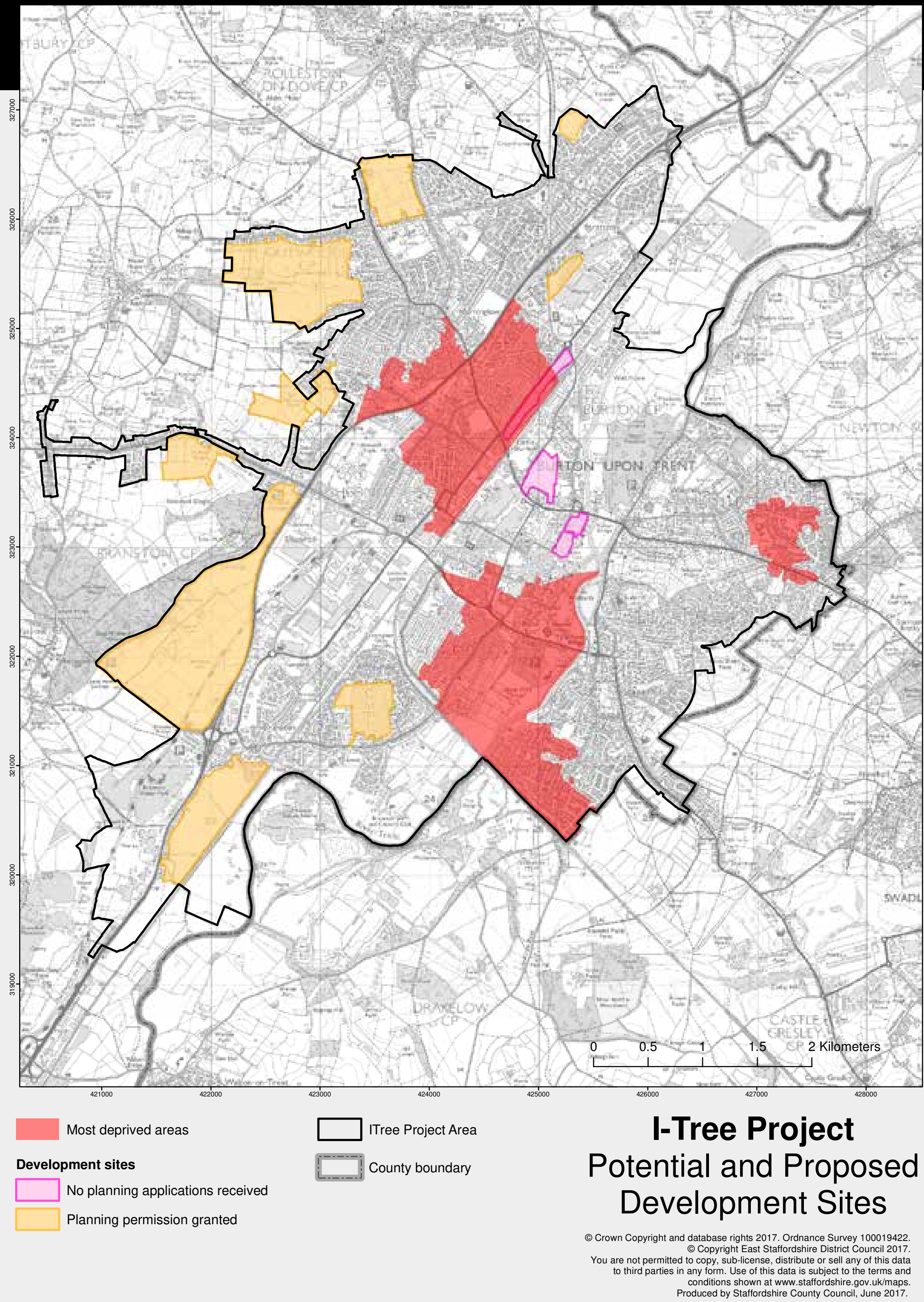
Urban forest can be used not only to enhance and regenerate existing places, but should also be considered when planning new developments. The East Staffordshire Local Plan has allocated large areas of land for development within or adjacent to the study area, with a proposal to develop 7000 new homes between 2012-2031. A high percentage of the current tree population (17%) is on land identified as being vacant which could become the focus for development, potentially threatening some 17,415 trees. The construction of new homes should also be regarded as an opportunity to incorporate suitable planting schemes and should be consistent with East Staffordshire Local Plan Strategic Policy 26. This policy specifies new developments should include significant amounts of new planting to reflect their location within The National Forest. This alone will make a substantial contribution to increasing canopy cover in the town over the life of the project.

Other key national and local policies encouraging planting and good design include Neighbourhood Plans, Chapter 1 of the East Staffordshire Design Guide and Section 7 of the National Planning Policy Framework.

Space for tree planting in most new developments is at a premium with the streets or gardens only having the capacity to support small ornamental trees. Space for large canopy species such as oak, beech and lime is rarely included in new smaller scale developments although there is greater capacity in urban extensions. Inclusion of tree planting within strategic open space for new major housing and industrial development is therefore of key importance if larger canopy tree cover in Burton is to be maintained and increased. As the town expands, inclusion for new/retained green infrastructure, connecting to the existing network, will be essential if the vision is to be attained.

Figure 17 identifies potential and proposed developments. These development sites provide key opportunities for tree planting to form a key part of the development designs.

FIGURE 17
DEVELOPMENT SITES AND MOST DEPRIVED AREAS.



AIM 8
INCREASE THE CONTRIBUTION OF THE URBAN FOREST TO CLIMATE CHANGE RESILIENCE AND MITIGATION

OBJECTIVES:

i. Plant species which will be resilient to the changing climate
ii. Plant species which provide adaptation measures to reduce the impacts of a changing climate
iii. Plant species with the ability for high carbon storage and sequestration

The urban forest can help to provide adaptation measures to reduce the effects of climate change.

The UK weather is getting more extreme. Over the last decade, we have seen a record heatwave, record cold winters and record flooding. The outcomes of climate change are largely unknown. Predictions forecast more abnormal, violent and unpredictable weather events coupled with an increase in day and night temperatures.

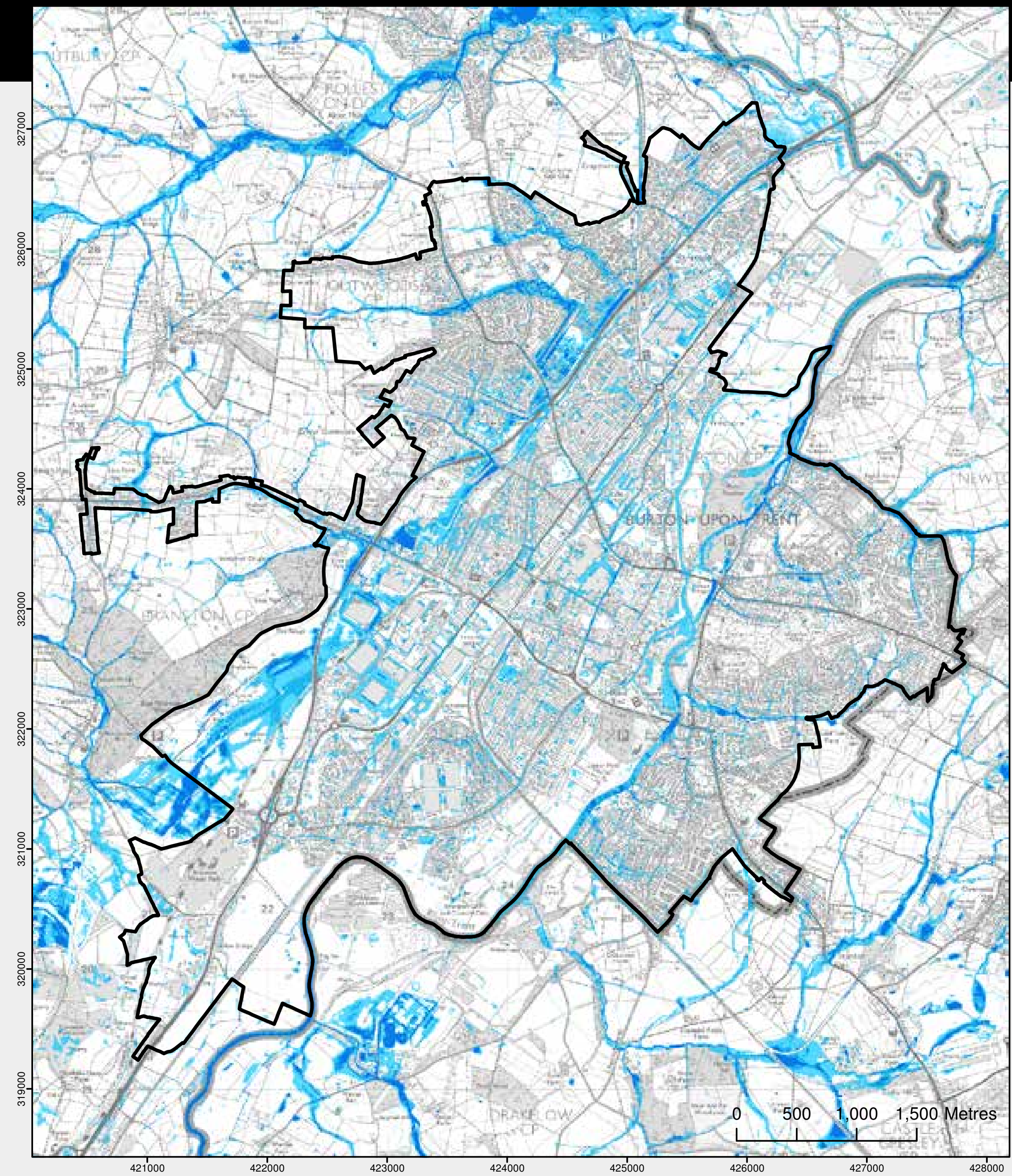
The urban forest can help to provide adaptation measures to reduce the effects of climate change impacts through:

i. Reducing surface runoff

Surface runoff can be a cause for concern in urban areas as it can lead to localised flooding and contribute to pollution of watercourses. Figure 18 identifies the areas most susceptible to surface water flooding. The canopies of trees and shrubs intercept precipitation, while their root systems promote infiltration and storage in the soil. One hundred mature trees can capture over one million litres of rainwater each year. For every 5% of tree cover in a community, storm water run-off can be reduced by 2%. It is estimated Burton's trees reduce runoff by 23,700 cubic meters a year by holding rainfall in the canopy. Elm, oak, willow and sycamore are the species providing the greatest runoff capture in Burton.

Tree planting should be considered as part of an overall surface water reduction strategy. For example the opportunity should be taken when tree planting to retrofit other forms of sustainable drainage systems (SUDS) where possible, such as swales, ponds, depressions to hold back water etc. However, tree planting schemes should also take into account that Burton has a complex network of culverts, open watercourses, diverted channels, sluices, pumps and basins and these require to be kept clear of tree roots and debris to allow clear flows.

FIGURE 18
SURFACE WATER FLOOD MAP



1 in 30 (3.33% AEP)
1 in 100 year (1% AEP)
1 in 1000 year (0.1% AEP)
ITree Project Area
County boundary

I-Tree Project
Environment Agency
Flood Map for Surface Water

ii. Carbon storage

The term carbon storage refers to the quantity of carbon currently held in trees tissue (roots, stems, and branches). Carbon storage depends not only on the number of trees present, but also their characteristics. The mass of the tree is extremely important as larger trees store more carbon throughout their lives. Total carbon storage for Burton trees is estimated at 19,800 tonnes. The largest trees surveyed in Burton's were oak and willow which also have been calculated to be storing the greatest amount of carbon. For example, one of the surveyed oak trees is calculated to be storing 1,810 kg of carbon, 10 times the average amount of carbon stored in Burton's trees. This emphasises the importance of retaining mature trees.

iii. Carbon sequestration

The carbon sequestration rate refers to the estimated annual amount of carbon removed by trees. It is estimated Burton's trees sequester 722 tonnes of carbon a year. One of Burton's mature oaks is sequestering the largest amount of carbon at 66 kg per year. Beech, birch, willow and sycamore also have high levels of carbon sequestration relative to the tree size.

iv. Cooling air temperatures

Towns and cities tend to have higher temperatures than rural areas due to lower levels of vegetation and the increased presence of built structures absorbing heat - a phenomenon termed the urban heat island effect. Heat-related stress from heat islands accounts for around 1,100 premature deaths per year in the UK. An estimated 8–11 extra deaths occur each day for each degree increase in air temperature during UK summer heatwaves (Doick and Hutchings). The occurrence and intensity of extreme heat events is set to increase under a changing climate, and these may be more readily experienced in urban areas. Tree species with a high leaf area are particularly effective through casting denser shade (Nature Conservancy), with large trees providing the greatest influence on air and surface temperatures. Research suggests that even moderate (10%) increases in tree and shrub canopy cover within cities can aid adaptation to the adverse effects projected under a changing climate and counter a projected 2 °C increase in ambient temperatures (Gill et al. 2007).

v. Energy consumption

Large deciduous trees around buildings can reduce energy use in buildings by acting as a wind break and allowing sunlight to penetrate buildings during winter months and provide shade during the summer. Evergreen trees can provide similar benefits, although creates more shading in winter.

As an example, in the US the shade effect of trees can lower the surface temperature of an outside wall by 17°C, lowering indoor air temperatures by 0.5°C and air-conditioning costs by 25–80%. At UK latitudes, trees on the west-facing side of a building provide good amounts of shade in summer and comparatively little in winter. Identical trees positioned on the south-facing side of a building cast relatively more shade in winter, a trend contrary to that required to reduce energy consumption (Santamour), considerations pertinent to any strategy to increase Burton's tree canopy cover.

To mitigate against the worst effects of predicted climate changes the tolerances of trees to be planted need to be considered. The characteristics to withstand flooding, tolerate heat, especially reflected heat and to provide shade are all of paramount importance.

Total carbon storage for Burton trees is estimated at 19,800 tonnes.

IMPLEMENTATION PLAN 2017-2022

The aims and objectives provide a framework for managing Burton's urban forest. This section identifies some specific actions that are recommended to conserve the urban forest and maximise its benefits to the community. The implementation plan considers the study area as a whole, but also identifies priority zones (see figure 19) where actions can be targeted to have the greatest positive impact. Implementation details are provided for the first 5 years in Table 5. It is anticipated these will be reviewed and refreshed for years 5-10.

Given there are multiple aims for the management strategy and local conditions vary across Burton, specific recommendations about species selection and locations have not been provided as these need to be balanced with other priorities. For example, priorities for Trent floodplain habitats include grassland and wetlands and increased woodland planting may not be appropriate. A range of trees with information on how these may contribute to the aims is provided in Appendix III as a guide.

This plan will be delivered by the Burton Tree project steering group which includes the following organisations: East Staffordshire County Council, Staffordshire County Council, the National Forest Company, Staffordshire Wildlife Trust and Burton Conservation Volunteers.

TABLE 5

FIVE YEAR IMPLEMENTATION PLAN

ACTION	WHERE	DELIVERY YEAR 1	2	3	4	5
1. SURVEY AND ASSESSMENT						
1.1 Survey open spaces						
Engage volunteers to survey publicly owned land to identify potential areas for planting (whips and standards)	Priority zones	✔				
	Study area				✔	✔
1.2 Survey veteran trees						
Engage volunteers to identify the location and general health of veteran trees on publicly owned land	Study area		✔	✔		
1.3 Tree Preservation Orders (TPO)						
Review TPOs and protect trees as appropriate	East Staffordshire	✔	✔	✔	✔	✔
2. PLANT						
2.1 Planting schedule for publicly owned land						
2.1.1 New Planting Schedule Produce and implement a collaborative phased plan of planting areas (whips and standards) consistent with the aims of the management strategy. Engage with volunteers for planting whips in open spaces	Priority zones		✔	✔	✔	✔
	Study area			✔	✔	✔
2.1.2 Amenity planting Identify retrofitting opportunities in association with street improvements to support the regeneration and improvement of areas	Priority zones	✔	✔	✔	✔	✔
2.2 Education						
2.2.1 Awareness raising Develop and implement media plan (all partners)	Study area	✔	✔	✔	✔	✔
2.2.2 Planting guide for developers and highways Design a toolkit for tree selection, planting and maintenance for use by developers and highways	East Staffordshire		✔			
2.2.3 Planting guide for residents Develop guidance for residents on planting and managing trees	Study area	✔				
2.2.4 School projects Design a learning plan for schools on seed collecting and planting and encourage participation	Study area			✔		
2.3 Planting projects						
2.3.1 Tree Planting scheme Develop a free tree planting scheme and promote to local residents in the winter	Study area	✔	✔	✔	✔	✔
2.3.2 Buy a tree for Christmas Annual promotional campaign to encourage gifting trees for Christmas	Study area	✔	✔	✔	✔	✔
2.3.3 Street names Identify streets with tree names and investigate opportunity to encourage planting related to the street name	Study area				✔	
2.4 Project branding Display the 'Burton Tree Project' brand for trees planted in association with this project	Study Area	✔	✔	✔	✔	✔
3. MANAGE						
3.1 Procurement						
Ensure all tree stock purchased has been appropriately quarantined	Study area	✔	✔	✔	✔	✔
3.2 Species planting list						
Maintain tree planting list and update as appropriate, for example new disease threats.	Study area	✔	✔	✔	✔	✔
3.3 Tree Protection						
Design a tree protection plan for veteran trees	Study Area				✔	
4. EVALUATE						
4.1 Review implementation plan						
Review implementation plan and schedule resurvey at year 10 using i-Tree-Eco methodology	Study area					✔

PRIORITY PLANTING ZONE

Priority zones should be considered as a priority for planting, subject to a full assessment on competing priorities and identification of any constraints to planting.

These areas are:

ZONE 1 – CENTRAL BURTON – HIGHEST PRIORITY AREA FOR PLANTING

This zone contains areas of deprivation, high levels of pollution, areas prone to surface water flooding and an important green corridor. Planting in this area should be considered the highest priority. This is a heavily urbanised area and the potential for larger scale woodland planting is limited. The area also falls within a green infrastructure corridor and the potential to provide better linkages should be investigated. Priority should be to protect and enhance the current trees and to investigate the potential for new planting of street trees and urban green spaces. Residents and businesses could also contribute through planting on their private land.

ZONE 2

This zone experiences high levels of pollution and includes the A38 and Derby Road, it has several areas prone to surface water flooding and falls within an important green corridor. The area is a mix of residential, industrial and agricultural. Mature tree cover is already present along the A38 corridor. There is the potential for a range of planting within this zone.

ZONE 3

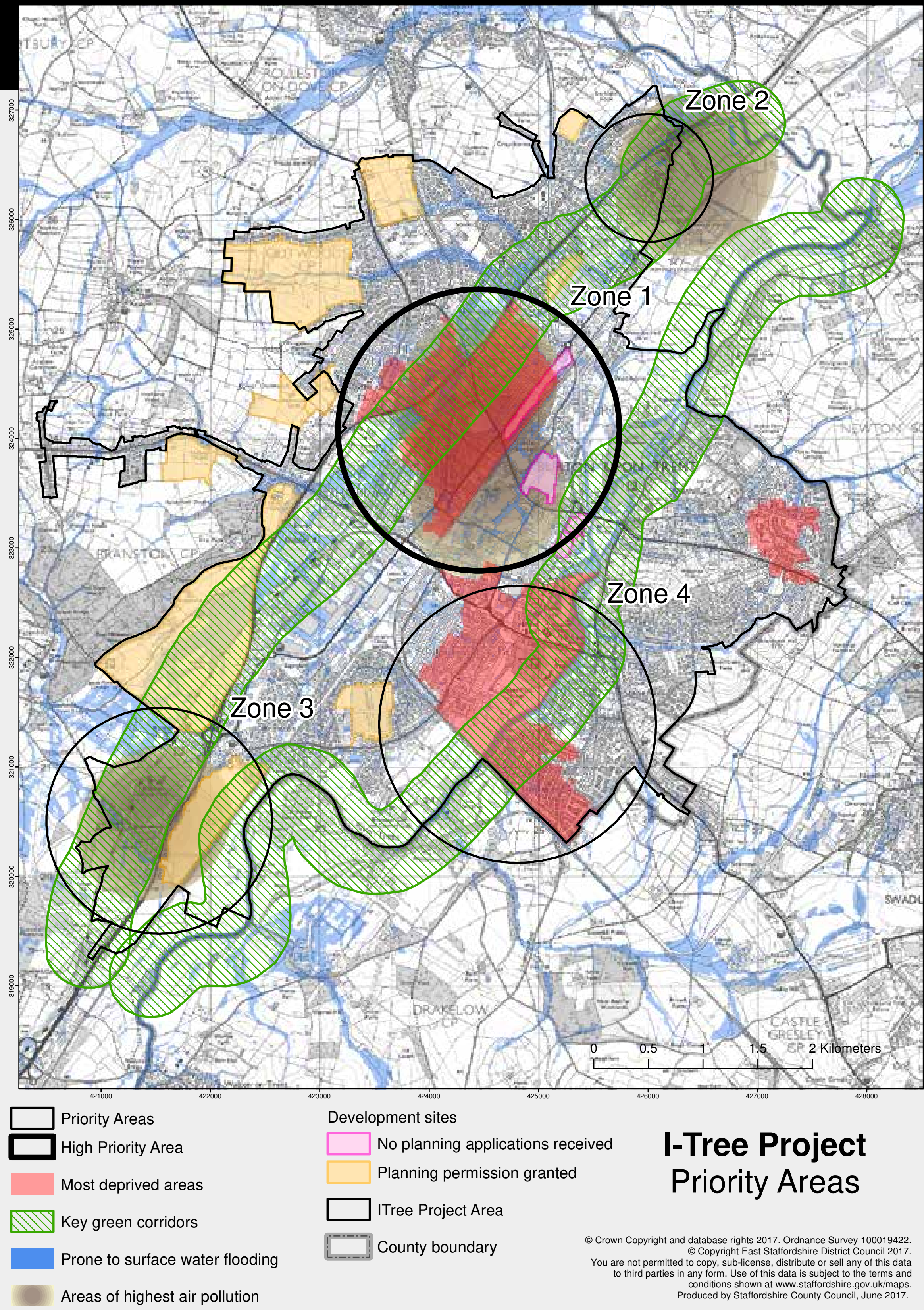
This zone experiences high levels of pollution and includes the A38, it has several areas prone to surface water flooding and falls within an important green corridor. The area is predominantly a mix of agricultural and industrial. Existing planting in this area is sparse and the potential for more extensive woodland planting may be possible. There is a large scale housing and employment development proposed. Outline permission has been granted discussions over the detail of individual landscaping schemes are ongoing and will be approved through reserved matters over the coming years.

ZONE 4

This area contains an area of high deprivation, an important green corridor and areas prone to surface water flooding, especially within the residential areas. There is a mix of residential, industrial and agricultural land use. The agricultural land falls mostly on floodplain for the River Trent which may limit the potential for large scale planting in this zone. Priority should be to protect and enhance the current trees and to investigate the potential for new planting of street trees and urban greenspaces. Residents and businesses could also contribute through planting on their private land.

FIGURE 19

PRIORITY AREAS FOR PLANTING



APPENDIX 1

FULL SPECIES LIST, BY 'IMPORTANCE VALUE'

TREES AND SHRUBS

Scientific Name	Common Name	Percent Population	Importance Value
Fagus sylvatica	Common beech	18.5	27.3
Acer pseudoplatanus	Sycamore	6.9	17.1
Fraxinus excelsior	Common ash	5.0	15.0
Crataegus monogyna	Hawthorn	7.7	13.4
Betula pendula	Silver birch	6.7	12.4
Quercus robur	English oak	3.4	11.2
Ulmus glabra	Wych elm	2.0	11.0
Acer platanoides	Norway maple	2.1	7.3
Salix spp. (generic)	Willow spp	2.3	6.8
Cupressocyparis leylandii	Leyland cypress	3.8	5.8
Salix fragilis	Crack willow	1.9	4.8
Acer campestre	Field maple	3.3	4.7
Ilex aquifolium	Common holly	3.1	4.6
Cupressus sempervirens	Italian cypress	2.6	4.5
Pinus spp. (generic)	Pine spp	2.0	4.4
Cotoneaster	Cotoneaster spp	1.3	3.9
Malus spp. (generic)	Apple spp	3.4	3.8
Salix caprea	Goat willow	1.0	3.4
Populus alba	White poplar	1.5	3.2
Tilia x europaea	Common lime	0.9	2.2
Sorbus aucuparia	Rowan	1.8	2.2
Cupressus	Cypress spp	1.9	2.1
Taxus baccata	English yew	1.1	1.8
Prunus spinosa	Blackthorn	0.9	1.7
Prunus laurocerasus	Cherry laurel	0.9	1.6
Pinus sylvestris	Scots pine	0.5	1.6
Populus nigra 'Italica'	Lombardy poplar	0.6	1.5
Salix purpurea	Purple Osier willow	0.7	1.4
Quercus petraea	Sessile oak	0.3	1.3
Prunus avium	Sweet cherry	1.3	1.3
Sambucus nigra	Purple Elder	0.8	1.2
Carpinus	Hornbeam spp	1.0	1.2
Salix alba	White willow	0.3	1.2
Sorbus aria	Whitebeam	0.9	1.2
Alnus x fallacina	Alder	0.3	1.0
Prunus spp. (generic)	Cherry spp	0.6	0.9
Salix x sepulcralis Simonkai	Weeping willow	0.3	0.9
Fagus sylvatica 'Purpurea'	Copper beech	0.6	0.8
Abies spp. (generic)	Fir spp	0.6	0.8
Picea abies	Norway spruce	0.5	0.8
Catalpa bignonioides	Southern catalpa	0.3	0.8
Chamaerops spp. (generic)	Fan palm spp	0.3	0.5
Ligustrum spp. (generic)	Privet spp	0.3	0.5
Viburnum spp. (generic)	Viburnum spp	0.3	0.5
Buddleja spp. (generic)	Butterfly Bush	0.3	0.4
Prunus cerasifera	Cherry plum	0.3	0.4
Pyracantha koidzumii	Formosa firethorn	0.3	0.4
Eucalyptus obliqua	Messmate stringybark	0.3	0.4
Araucaria araucana	Monkey puzzle tree	0.3	0.4
Robinia spp. (generic)	Robinia spp	0.3	0.4
Alnus spp. (generic)	Alder spp	0.3	0.3
Eugenia monticola	Bird Cherry	0.3	0.3
Camellia japonica	Camellia	0.3	0.3
Syringa vulgaris	Common lilac	0.3	0.3
Acer spp. (generic)	Maple spp	0.3	0.3
Reynosia uncinata	Sloe	0.3	0.3

APPENDIX 2

SUMMARY OF MANAGEMENT STRATEGY AIMS

	Aim 1	Aim 2	Aim 3	Aim 4	Aim 5	Aim 6	Aim 7	Aim 8
Aim 1 Increase overall tree cover								
Increase tree cover by creating at least 30 hectares of new planting	✔	✔	✔	✔	✔	✔	✔	✔
Aim 2 Develop a more diverse age structure								
Survey and create an inventory of veteran trees		✔						
Review the use of Tree Preservation Orders to ensure that trees stature trees are protected as appropriate		✔		✔	✔	✔	✔	✔
Encourage a proportion of all new species selected for planting have the genetic capacity to grow into a large mature tree	✔	✔		✔	✔	✔	✔	✔
Encourage active management of mature trees		✔		✔	✔	✔	✔	✔
Aim 3 Improve the species diversity to increase resilience								
Design for species diversity in line with good practice for resilience	✔		✔		✔	✔	✔	✔
Purchase British grown trees where possible. Any imported species should have been appropriately quarantined			✔					
Aim 4 Enhance biodiversity								
New planting schemes to include species of high biodiversity value	✔			✔	✔	✔	✔	✔
Target new planting to enhance ecological networks	✔		✔	✔	✔	✔	✔	✔
Aim 5 Enhance the sense of place and amenity value								
Locate planting to improve green spaces	✔			✔	✔	✔	✔	✔
Respect the landscape character in planting design and species selection.	✔				✔	✔	✔	✔
Use planting to buffer new development to maintain the wider landscape qualities	✔				✔	✔	✔	✔
Enhance the sense of place, particularly in more deprived parts of the town through increasing tree cover	✔			✔	✔	✔	✔	✔
Aim 6 Increase the contribution of the urban forest to public health outcomes								
Increase 'greenness' in residential areas to improve mental health and wellbeing	✔				✔	✔	✔	✔
Seek to plant trees which have the greatest capacity to capture pollution in the urban centre where air quality is poorest	✔				✔	✔	✔	✔
Explore initiatives to encourage residents to increase tree and shrub cover in gardens	✔		✔	✔		✔		✔
Aim 7 Increase the contribution of the urban forest to the local economy and maximise opportunities from new developments								
Ensure that all development proposals take into consideration tree cover by retention of existing trees and mitigation planting.	✔			✔	✔	✔	✔	✔
Incorporate planting of trees capable of becoming larger mature specimens into new developments where appropriate	✔	✔		✔	✔	✔	✔	✔
Prepare a planting guide for new developments	✔	✔	✔	✔	✔	✔	✔	✔
Support the regeneration and improvement of areas through amenity planting	✔			✔	✔	✔	✔	✔
Aim 8 Increase the contribution of the urban forest to climate change resilience and mitigation								
Plant species which will be resilient to the changing climate	✔		✔	✔	✔	✔	✔	✔
Plant species which support adaptation measures to reduce the impacts of a changing climate	✔		✔		✔	✔	✔	✔
Plant species with the ability for high carbon storage and sequestration	✔		✔	✔	✔	✔	✔	✔

APPENDIX 3

SPECIES GUIDE

COMMON NAME	BOTANICAL NAME	NATIVE	PRESENT IN BURTON NOW	SUITABLE STREET TREE	SUITABLE FOR HEDGE PLANTING AS HEDGEROW SHRUB	SIZE AT MATURITY	LONG LIVED TREES	TOLERANT OF FLOODING AND WET CONDITIONS	TOLERANT OF DROUGHT CONDITIONS	HIGH LEVEL OF POLLUTION ABSORPTION	POTENTIAL FOR HIGH CARBON STORAGE	POTENTIAL FOR HIGH BIODIVERSITY VALUE	POTENTIAL FOR HIGH RAINWATER RETENTION IN THE CANOPY	PEST AND DISEASE RISK	COMMENTS
Field Maple	***Acer campestre***	✔	✔	✔	✔	**S/M**				✔		✔		Squirrels	*Acer campestre* 'Streetwise' suitable for street situations. Also consider 'Queen Elizabeth', 'Elegant', 'William Caldwell', 'Lianco'
Norway Maple	***Acer platanoides***			✔		**L**									Consider *Acer Platanoides* 'Obelisk', 'Columnare', Cleveland', 'Olmstead' for street trees.
Sycamore	***Acer platanoides***		✔			**L**				✔				Squirrels, Black Spot, Sooty Bark	Not recommended as seeds itself freely. Acer platinodes varieties may be more appropriate.
Red Maple	***Acer rubrum***			✔		**L**				✔					
Horse Chestnut	***Aesculus hippocastanum***		✔	✔		**L**				✔				Giant polypore, leaf minor, bleeding canker	*Aesculus* 'Baumanni' is sterile (and therefore no conkers), but wide spreading and needs space.
European Alder	***Alnus glutinosa***	✔				**M**		✔		✔				Phytophora Alni	*Alnus cordata* (not native) tolerates dryer soils or wet soils.
Snowy Mespil	***Amelanchier arborea***			✔		**S**									Consider *Amelanchier arborea* 'Robin Hill' for all year round interest with spring flowers, interesting foliage and good Autumn colour.
Silver Birch	***Betula pendula***	✔		✔		**L**									Consider *Betual pendula* 'Fastigiata', 'Obelisk' for street trees.
Birch	***Betula pubescens***	✔	✔	✔	✔	**M**		✔		✔		✔			*Betula nigra* tolerates wet soils.
European Hornbeam	***Carpinus betulus***	✔		✔		**M**				✔		✔		Squirrels	Formal hedging only. *'Carpinus betulus 'Fastigiata'*, 'Frans Fontaine' or 'Streetwise' may be suitable for street situations.
Sweet Chestnut	***Castanea sativa***					**L**	✔							Phytophthora ramorum	Only suitable in parkland situation with plenty of space.
European Filbert (Hazel)	***Corylus avellana***	✔	✔		✔	**S/M**				✔		✔			Generally grows as multi stem shrub

APPENDIX 4

PESTS AND DISEASES –

Pests and diseases are a serious threat to urban forests. Severe outbreaks have occurred within living memory, with Dutch Elm Disease killing approximately 30 million trees in the UK (Webber 2010). Climate change may exacerbate this problem, ameliorating the climate for some pests and diseases (Forestry Commission 2014). Assessing the risk pests and diseases pose to urban forests is of paramount importance.

A risk matrix was used to determine the potential impact of a pest or disease should it become established in the urban tree population of Burton on a single genus (Table 1) and for multiple genera (Table 2).

TABLE 1

Risk matrix used for the probability of a pest or disease becoming prevalent in the Burton urban forest on a single genus (one or more species).

PREVALENCE	% POPULATION		
	0-5	6-10	>10
NOT IN UK			
PRESENT IN UK			
PRESENT IN MIDLANDS			

TABLE 2

Risk matrix used for the probability of a pest or disease becoming prevalent in the Burton urban forest on multiple genera.

PREVALENCE	% POPULATION		
	0-25	26-50	>50
NOT IN UK			
PRESENT IN UK			
PRESENT IN MIDLANDS			

TABLE 3

PEST AND DISEASES PRESENT IN THE UK: IMPACT ASSESSMENT FOR BURTON'S URBAN FOREST – RANKED BY RISK THEN % POPULATION VULNERABLE

Tables 3 provides an impact assessment of the potential impact on Burton's trees from pests and diseases currently present in the UK. Table 4 considers known pests and diseases not currently known to be in the UK, although considered to be a potential threat.

Pest/Pathogen	Species affected	Prevalence in the UK	Prevalence in Midlands	Risk of spreading to Midlands	Population at risk (%)	CAVAT value of sampled trees (£)	Stored carbon value trees(£)
Giant polypore	*Primarily Quercus spp., Fagus spp., Aesculus spp., Sorbus spp.; Prunus*	Common in urban areas	Common in urban areas	High - already present	28.7%	309,905	440,200
Chalara dieback of ash	*Fraxinus excelsior, F. angustifolia*	Cases across the UK	Confirmed cases in Midlands	High - already present	5.2%	115,911	78,876
Gypsy Moth	*Primarily Quercus sp., secondarily Carpinus betulus, F. sylvatica, C. sativa, B. pendula and Populus sp.*	London, Aylesbury and Dorset	None	Medium risk – slow spreading	30.5%	419,246	516,200
Phytophthora kernoviae	*F. sylvatica, Ilex aquifolium, Q. robur, Q. ilex*	Mainly SW England and Wales	None	Medium risk	24.7%	280,515	415,512
Phytophthora ramorum	*Q. cerris, Q. rubra, Q. ilex, F. sylvatica, C. sativa, Larix decidua, L. x eurolepsis*	Many UK sites, particularly in S Wales and SW England	Some cases reported in the Midland	High - already present	21.6%	185,823	144,355
Phytophthora kernoviae	*F. sylvatica, Ilex aquifolium, Q. robur, Q. ilex*	Mainly SW England and Wales	None	Medium risk	24.7%	280,515	415,512
Acute oak decline	*Quercus robur, Q. petraea*	SE England, Midlands, East Anglia, Welsh border	None	High - already present	3.7%	81,752	274,400
Oak processionary moth	*Quercus spp.*	Southern England	None	Medium, small colonies are containable	3.7%	81,752	274,400
Dothistroma (red band) needle blight	*Pinus nigra ssp. laricio, P. contorta var. latifolia, Pinus sylvestris*	Several UK sites	Throughout Midlands	High - already present	0.6%	23,108	10,664
Phytophthora alni	*Alnus spp.*	Riparian ecosystems in the UK	Present on river systems	High - already present	0.6%	9,770	4,551

TABLE 4

PEST AND DISEASES NOT CURRENTLY IN THE UK: IMPACT ASSESSMENT FOR BURTON'S URBAN FOREST

Pest/Pathogen	Species affected	Prevalence in the UK	Prevalence in Midlands	Risk of spreading to Midlands	Population at risk (%)	CAVAT value of sampled trees (£)	Stored carbon value trees(£)
Spruce bark beetle	*Picea spp.*	Mainly W England, Southern Scotland and Wales	None	Medium risk	0.6%	2,435	874
Asian longhorn beetle	Many broadleaf species (see Appendix IV)	None (previous outbreaks contained)	Common in urban areas	Medium risk – climate may be suitable	61.0%	786,579	576,178
Oak Wilt	*Quercus spp.*	None	None	Medium risk	3.7%	81,752	274,400
Elm yellows	*Ulmus spp.*	None (outbreak in 2014)	None	Medium risk	1.8%	24,944	15,723
Xylella fastidiosa	*Quercus robur, Ulmus glabra, Platanus occidentalis* and *Quercus rubra*	None	None	Medium risk	5.2%	88,286	267,933
Phytophthora siskiyouensis	*Alnus spp.*	None	None	Medium risk	0.6	9,770	4,551

APPENDIX 5

FURTHER INFORMATION ON THE PESTS AND DISEASES

ACUTE OAK DECLINE

Acute oak decline (AOD) affects mature trees (>50 years old) of both native oak species (common oak and sessile oak). Over the past four years, the reported incidents of stem bleeding, a potential symptom of AOD, have been increasing. The incidence of AOD in Britain is un-quantified at this stage but estimates put the figure at a few thousand affected trees. The condition seems to be most prevalent in the Midlands and the South East of England as far west as Wales. So far there are no confirmed cases in Staffordshire and as the disease spreads slowly acute oak decline poses a medium risk to the Burton's urban forest.

ASIAN LONGHORN BEETLE

Asian Longhorn Beetle (ALB) is a major pest in China, Japan and Korea, where it kills many broadleaved species. In America, ALB has established populations in Chicago and New York. Where the damage to street trees is high felling, sanitation and quarantine are the only viable management options. In March 2012 an ALB outbreak was found in Maidstone, Kent. The Forestry Commission and Fera removed more than 2, 000 trees from the area to contain the outbreak. No further outbreaks have been reported in the UK. MacLeod, Evans & Baker (2002) modelled climatic suitability for outbreaks based on outbreak data from China and the USA and suggested that CLIMEX (the model used) Ecoclimatic Indices of >32 could be suitable habitats for ALB, suggesting Burton may be vulnerable to ALB. If an ALB outbreak did occur in Burton it would pose a significant threat to 61.0% of the trees, not including attacks on shrub species. The known host tree and shrub species include: Acer spp. (maples and sycamores); *Aesculus* spp. (horse chestnut); *Albizia* spp. (Mimosa, silk tree); *Alnus* spp. (alder); *Betula* spp. (birch); *Carpinus* spp. (hornbeam); *Cercidiphyllum japonicum* (Katsura tree); *Corylus* spp. (hazel); *Fagus* spp. (beech); *Fraxinus* spp. (ash); *Koelreuteria paniculata; Platanus* spp. (plane); *Populus* spp. (poplar); *Prunus* spp. (cherry, plum); *Robinia pseudoacacia* (false acacia/black locust); *Salix* spp. (willow, sallow); *Sophora* spp. (Pagoda tree); *Sorbus* spp. (mountain ash/rowan, whitebeam etc); *Quercus palustris* (American pin oak); *Quercus rubra* (North American red oak); *Ulmus* spp. (elm).

CHALARA DIEBACK OF ASH

Ash dieback, caused by the fungus *Hynenoscyphus fraxineus*, targets common and narrow leaved ash. Young trees are particularly vulnerable and can be killed within one growing season of symptoms becoming visible. Older trees take longer to succumb, but can die from the infection after several seasons. *H. fraxinea* was first recorded in the UK in 2012 in Buckinghamshire and has now been reported across the UK, including in urban areas. Ash dieback poses a threat to 5.2% of Burton's urban forest.

DOTHISTROMA NEEDLE BLIGHT

Dothistroma (red band) needle blight is the most significant disease of coniferous trees in the North of the UK. The disease causes premature needle defoliation, resulting in loss of yield and, in severe cases, tree death. It is now found in many forests growing susceptible pine species, with Corsican, lodgepole and, more recently, Scots pine all being affected. While there are no reported cases of red band needle blight on urban trees, 0.6% of Burton's urban forest is potentially at threat from it.

ELM YELLOWS

Elm yellows (EY) is a disease of elm trees caused by a type of bacterium known as a phytoplasma. The disease is not present in the UK although we had an outbreak in 2014. The disease causes a range of symptoms that could include yellowing, dwarfing and premature shedding of leaves, formation of 'witches' brooms' at the tips of twigs and branches, early opening of buds, and in some occasions reddish colouration of the foliage. In very susceptible elms the phloem (inner bark) of the tree is attacked (hence the other name of the diseases: elm phloem necrosis), effectively girdling and stopping the flow of water and nutrients. Elm yellows disease can be spread by insects such as leafhoppers, and by the movement of infected plants. Symptoms can easily be confused for symptoms of Dutch elm disease (DED). However, trees affected by DED will die back and die rapidly, whereas EY could be expected to cause symptoms which do not result in the death of the tree. Elm yellows can affect healthy elm trees that are resistant DED. If Elm yellows became established in the UK it would pose a threat to 1.8% of Burton's urban forest.

EMERALD ASH BORER

There is no evidence to date that emerald ash borer (EAB) is present in the UK, but the increase in global movement of imported wood and wood packaging poses a significant risk of its accidental introduction. EAB is present in Russia and is moving West and South at a rate of 30-40km per year, perhaps aided by vehicles (Straw et al. 2013). EAB has had a devastating effect in the USA due to its accidental introduction and could add to pressures already imposed on ash trees from diseases such as Chalara dieback of ash. Emerald Ash borer poses a potential future threat to 5.2% of Burton's urban forest.

GIANT POLYPORE

Giant polypore (*Meripilus giganteus*) is a fungus that can cause internal decay in trees without any external symptoms (Schmidt 2006), causing trees to potentially topple or collapse (Adlam 2014). It is particularly common in urban areas and can also cause defoliation and crown dieback (Schmidt 2006; Adlam 2014). Giant polypore predominantly affects hardwoods such as horse chestnut, beech, cherry, mountain ash and oak. 28.7% of Burton's urban forest could be vulnerable to giant polypore.

GREAT SPRUCE BARK BEETLE

The great spruce bark beetle (*Dendroctonus micans*) damages spruce trees by tunnelling into the bark of the living trees to lay its eggs under the bark, and the developing larvae feed on the inner woody layers. This weakens, and in some cases can kill, the tree. The great spruce bark beetle poses a threat to 0.6% of Burton's urban forest.

GYPSY MOTH

Gypsy moth (GM), *Lymantria dispar*, is an important defoliator of a very wide range of trees and shrubs in mainland Europe, where it periodically reaches outbreak numbers. It can cause tree death if successive, serious defoliation occurs on a single tree. A small colony has persisted in northeast London since 1995 and a second breeding colony was found in Aylesbury, Buckinghamshire in the summer of 2005. Aside from these disparate colonies, GMs range in Europe does not reach as far North as the UK. Some researchers suggest that the climate in the UK is currently suitable for GM should it arrive here and that it would become more so if global temperatures rise (Vanhanen et al., 2007). However, the spread of gypsy moth in the USA has been slow, invading less than a third of its potential range (Morin et al., 2005). If GM spread to the Midlands, it would pose a threat to 30.5%of Burton's urban trees.

OAK PROCESSIONARY MOTH

Established breeding populations of oak processionary moth (OPM) have been found in South and South West London and in Berkshire. It is thought that OPM has been spread on nursery trees. The outbreak in London is now beyond eradicating, whereas efforts to stop the spread out of London and to remove those in Berkshire are underway. The caterpillars cause serious defoliation of oak trees, their principal host, but the trees will recover and leaf the following year. On the continent, they have also been associated with hornbeam, hazel, beech, sweet chestnut and birch, but usually only where there is heavy infestation of nearby oak trees. The caterpillars have urticating (irritating) hairs that carry a toxin that can be blown in the wind and cause serious irritation to the skin, eyes and bronchial tubes of humans and animals. They are considered a significant human health problem when populations reach outbreak proportions, such as those in The Netherlands and Belgium have done in recent years. Oak processionary moth poses a threat to 3.7% of Burton's urban forest.

OAK WILT

It is caused by the fungus *Ceratocystis fagacearum* and is currently only known to be present in the USA, although European oak species are susceptible and can be killed by the disease. It causes a vascular wilt disease which has resulted in the mortality of many thousands of native oak species in the north-central United States. The foliage of affected trees rapidly wilts and turns brown. Some of the dead leaves can persist on the trees for long periods. Occasionally individual leaves may become brown from the leaf apex, with the base of the leaf remaining green. Some diffuse staining may be observed in the outermost xylem ring. Local spread of *C. fagacearum* in the USA occurs from tree to tree through root connections or root grafts, resulting in expanding infection centres. Above ground and over longer distances, the speed of spread is dependent on the availability and effectiveness of suitable insect vectors. In urban areas where susceptible oaks are abundant, the impact on property or other social values has also been significant. In central Texas, for instance, oak wilt has caused considerable decline in urban and rural property values through landscape degradation, shade loss and a resulting decline in property values. If Oak Wilt became established in the UK it would pose a threat to 3.7% of Burton's urban forest.

PHYTOPHTHORA ALNI

Phytophthora alni affects all alder species in Britain which was first discovered in the country in 1993. Phytophthora disease of alder is now widespread in the riparian ecosystems in the UK where alder commonly grows. On average, the disease incidence is highest is southeast England. However, heavy losses are occurring in some of the alder populations that occur along English rivers. *Phytophthora alni* poses a threat to 0.6% of Burton's urban forest.

PHYTOPHTHORA KERNOVIAE

Phytophthora kernoviae (PK) was first discovered in Cornwall in 2003. The disease primarily infects rhododendron and bilberry (*Vaccinium*) and can cause lethal stem cankers on beech. PK has not been found in the Midlands. *Phytophthora kernoviae* is deemed to pose a risk to 24.7% of Burton's urban forest and also affects many of the shrub species identified in the survey.

PHYTOPHTHORA LATERALIS

The main host of *Phytophthora lateralis* is Lawson Cypress (*Chamaecyparis lawsonia*). It has resulted in the decline of Lawson Cypress hedgerows, with lesions spreading up the lower stem, resulting in crown death. Although there is less than 2200 hectares of commercially grown Lawson Cypress in Britain there is a huge risk to amenity and garden Lawson Cypress.

PHYTOPHTHORA RAMORUM

Phytophthora ramorum was first found in the UK in 2002 and primarily affects species of oak (Turkey oak, Red oak and Holm oak), beech and sweet chestnut. However, it has also been known to occasionally infect European and hybrid larch and kills Japanese larch. Rhododendron is a major host, which aids the spread of the disease. A few cases have been identified in the Midlands. *Phytophthora ramorum* poses a threat to 21.6% of Burton's urban forest.

PHYTOPHTHORA SISKIYOUENSIS

Phytophthora siskiyouensis is a recently-described species in the USA, isolated from stem lesions on myrtlewood (*Umbellularia californica*) and tanoak (*Nothocarpus densiflorus*) and from soil and stream water, in south-west Oregon. However, it has also been recorded as an aggressive pathogen of alders in urban environments. It has been reported causing stem lesions on Italian alder (*Alnus cordata*) in California, it was isolated from cankers on planted black alder (*Alnus glutinosa*) in Australia and it was detected in the UK on European alder (*Alnus incana*) causing stem bleeding cankers. The symptoms are similar to those caused by *P. alni*. If *Phytophthora siskiyouensis* became established in the UK it would pose a threat to 0.6% of Burton's urban forest.

SWEET CHESTNUT BLIGHT

Sweet chestnut blight is a fungal infection affecting sweet chestnut (*Castanea sativa* and *C. dentata*). *Q. robur, Q. petraea* and *Q.ilex* may also be infected, though in these species it is rarely fatal.

XYLELLA FASTIDIOSA

Xylella fastidiosa is a quarantine organism, not present in the UK. *X. fastidiosa* is a bacterium that affects its host plants by invading their water-conducting systems and blocks or restricts the movement of water and nutrients through the plant, resulting on wilting, stunting, dieback or death. There are different subspecies of *X. fastidiosa* and *X. fastidiosa* ssp. multiplex has a wide host range that include Britain's native pedunculate oak (*Quercus robur*) and wych elm (*Ulmus glabra*), as well as plane (*Platanus occidentalis*) and northern red oak (*Q. rubra*). Xylella is exclusively transmitted by xylem-fluid feeding insects from the Cicadellidae and Ceropidae families. There are several species of insects in the UK which could vector (spread) *X. fastidiosa*, including the common froghopper (*Philaenus spumarius*). The symptoms on infected trees are marginal leaf scorch (browning) often showing a yellow edge to the browned areas, wilting of foliage, dieback of branches and death. If *Xylella fastidiosa* became established in the UK it would pose a threat to 5.5% of Burton's urban forest.

APPENDIX 6

BIODIVERSITY BENEFITS OF DIFFERENT TREE SPECIES

The number of species on insects associated with British trees: a re-analysis (Kennedy and Southwood)

COMMON NAME	SCIENTIFIC NAME	BEETLES	FLIES	TRUE BUGS	WASPS AND SAWFLYS	MOTHS AND BUTTERFLIES	OTHER	TOTAL
Willow spp	*Salix spp*	64	34	56	104	162	9	450
English oak & Sessile oak	*Quercus robur & Quercus petraea*	67	7	81	70	189	9	423
Birch	*Betula*	57	5	30	42	179	9	334
Common hawthorn	*Crataegus monogyna*	20	5	40	12	124	8	209
Poplar spp	*Populus spp*	32	14	42	29	69	3	189
Scots pine	*Pinus sylvestris*	87	2	25	11	41	6	172
Blackthorn	*Prunus spinosa*	13	2	25	7	91	11	153
European alder	*Alnus glutinosa*	16	3	32	21	60	9	141
Elm	*Ulmus*	15	4	22	6	55	11	124
European crabapple	*Malus sylvestris*	9	4	12	2	71	2	118
European filbert	*Corylus avellana*	18	7	19	8	48	6	106
Common beech	*Fagus sylvatica*	34	6	11	2	41	4	98
Norway spruce	*Picea abies*	11	3	14	10	22	1	70
Common ash	*Fraxinus excelsior*	1	9	7	7	25	9	68
Rowan	*Sorbus aucuparia*	8	3	6	6	33	2	58
Lime	*Tilia*	3	5	14	2	25	8	57
Field maple	*Acer campestre*	2	5	10	2	24	6	51
European hornbeam	*Carpinus betulus*	5	3	10	2	28	2	51
Sycamore	*Acer pseudoplatanus*	2	3	11	2	20	5	43
European larch	*Larix decidu*	6	1	9	5	16	1	38
Common juniper	*Juniperus communis*	2	5	1	1	15	2	32
Fir spp	*Abies*	8	0	0	0	3	0	11
Sweet chesnut	*Castanea sativa*	1	0	1	0	9	0	11
Common holly	*Ilex aquifolium*	4	1	2	0	3	0	10
Horsechestnut	*Aesculus hippocastanum*	0	0	5	0	2	2	9
English walnut	*Juglans regia*	0	0	2	0	2	3	7
English yew	*Taxus baccata*	0	1	1	0	3	1	6
Holly oak	*Quercus/live ilex*	0	0	1	0	4	0	5
Black locust								
Robinia	*Robina pseudoacacia*	0	0	1	1	0	0	2

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NOTES

NOTES

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